MAIN CURRENTS

IN MODERN THOUGHT

FOUNDATION FOR INTEGRATED EDUCATION · 1947 ·

The history of humanity shows that social systems aiming at justice rest ultimately upon some degree of philosophical as well as upon material, psychological, and historical circumstances of that society. World law for justice and freedom calls for the steady evolution of a world consensus. Science is coin of the world realm. The elucidation of the concepts of science, in terms which permit the humanities to use them, constitutes indispensible preparation for enduring world settlement. The natural order which the sciences assume, study, and teach confirms freedom, for freedom is dependent upon knowledge of order.

VOL. 8 NO. 4

MAIN CURRENTS IN MODERN THOUGHT

A co-operative journal to promote the free association of those working toward the integration of all knowledge through the study of the whole of things, Nature, Man, and Society, assuming the universe to be one, dependable, intelligible, harmonious.

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"Ah, but a man's reach should exceed his grasp, or what's a heaven for?" — BROWNING

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AIMS OF THE FOUNDATION FOR INTEGRATED EDUCATION

The Foundation is incorporated under the laws of the State of New York as a non-profit educational organization. Contributions are tax deductible.

The corporate statement of Aims declares that the Foundation has been established:

1. To collect, create, and distribute authoritative materials which will encourage the development of unified overall concepts in education; to improve the balance of relationships between the physical sciences and the social sciences; to inquire into the phenomena of purposive activity in nature, man and the universe.

2. To assist teachers to understand and use such materials, and to develop an active, realistic, comprehensive philosophy which will communicate to their students the unity, coherence, and beauty of the world in which we live.

3. To remedy, solely by such educative measures, the conceptual and hence the ethical, social, economic, and political breakdown of our times, looking to a peaceful world order.

The members, associates, and staff of the Foundation realize that the progressive discovery of unifying over-all concepts concerning man and the universe is not a task to be performed successfully in isolation from the historical, social, economic, and political context of our times, nor in terms of application less than global.

The work of the Foundation is wholly educational, yet is referred constantly to the contemporary scene in all its aspects, no less than to the total available wealth of human experience and knowledge.

MAIN CURRENTS IN MODERN THOUGHT is published quarterly to call attention to significant contributions to learning currently being made by leading workers in the multiple fields into which knowledge has come to be classified. It relates these advances to each other and to the classical and contemporary views of Eastern, European and American thinkers. It is designed to save time for the reader by providing a vantage-ground from which the whole world of knowledge may be surveyed and kept in proportion as it moves toward integration. Its editors assume that the principles of art, the universals of philosophy, the laws of Nature and Man as formulated by science, and the truths of comparative religion, can be orchestrated into a harmonic, meaningful, ethical body of teachings which can and should be made the central core of curricular study in the educative process at all levels of development. In condensing text, square brackets [ ] indicate editorial interpolation. Three dots . . . in the text indicates a word, phrase or passage omitted in the interest of brevity or clarity. Other usages are standard. $3.00 a year. Foreign $3.50. Contributors to MAIN CURRENTS enjoy full liberty of opinion and expression in these pages.

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THE FOUNDATION FOR INTEGRATED EDUCATION

NEWS AND NOTES

The considerable success thus far of the first collaboration between a great university and the Foundation for Integrated Education has encouraged its co-sponsors, at the initiative of colleagues in the Division of General Education and the School of Education of New York University, to discuss continuance next year of the course, "The Frontier of Knowledge: Integrative Concepts in Science, Philosophy, and Education." The result of these conversations will be reported in due time.

In originating the course, the choice was: (1) to select the speakers from one faculty so as to make it possible for each lecturer to attend all of the occasions, or (2) to have the subjects treated by the men in each field, drawn from many university faculties. The latter alternative gave a wider range, enabled the course chairman to take many considerations into account, and was the choice made, with full awareness that the wider significance of any given principle would have to be brought out in discussion and pointed up in summary lectures. As readers of Main Currents are aware, a substantial number of the lecturers conferred last summer at the Durham, New Hampshire, Workshop, and various other auxiliary aids are being used to make the utmost of the integrative elements. Fortunately the student group is doing its full part in the discussion period. Tuesday evenings are lively business in the comfortable little theatre, Room 703 of Main Building at New York University. The courtesy, solicitude, and effective management of Dean Paul A. McGhee and his immediate colleagues in the Division of General Education, and of Professor George Axtelle and Professor Theodore Brameld of the School of Education are gratefully recognized as contributory to enriching evenings.

The course has attracted 116 registered students. Of these 88 come through the Division of General Education, where credit is not offered, and 28 through a graduate level of the School of Education, with accrediting to Teachers College, Columbia University, and elsewhere. The analysis of the audience is of considerable interest. It reveals, among other features, a deep desire to have science "put together" so that its relation to philosophy and to education can be better appreciated.

Following is a summary analysis of those in the audience who replied to a questionnaire:

Place of Residence: New York City, 61; Suburban New York, 21; New York State, 2; Connecticut, 2; Pennsylvania, 1; Vermont, 6.

Educational Background: Doctorial, 16; masters, 25; bachelors, 33; post high school, 7; high school, 1.

Date of Most Recent Formal Education: 1943-1951, 49; 1933-1942, 13; 1923-1932, 9; 1908-1922, 7.

Present Position or Occupation: Among 40 persons in educational work are 7 college administrators, 11 college teachers, and 19 high school teachers. Six graduate students not otherwise employed are represented. The 19 persons in professional fields include clergymen, engineers, lawyers, medical doctors, dentists, and social workers. Of 16 persons in business occupations, executives and others in a number of fields are represented.

Fields of Major Professional Interest: In the educational field: college administration, 2; education, 18; natural science, 19; social sciences and psychology, 7; humanities, 6. In the professional field, 18. In business, 9.

Fields of Major Avocational Interest: Arts, 17; science, 15; education, 7; social sciences, 20; literature and languages, 4.

Motivation of Interest in the Course: Educational, 33, including 10 desirous of a broader educational background; scientific, 13; philosophical and socio-ethical, 8.

Intended Applications of Results of the Course: Educational, 27; scientific, 2; philosophical and ethico-social, 10; personal, 12.

Science Courses Taken: Elementary or none, 10; college, one course, 6; two courses, 17; three courses, 15; four courses, 6; five courses, 2; six courses, 3; seven courses, 1; complex, 10.

Philosophy and Social Science Courses Taken: Elementary or none, 3; unclassifiable, 16; college, one course, 8; two courses, 13; three courses, 7; four courses, 5; seven courses, 1; complex, 4.

General announcement (through Main Currents) of the present course at New York University has brought to the Foundation a very considerable number of statements and appeals which show dissatisfaction with general education in forward-looking faculty and administrative groups on many campuses. The executive dean of a university wrote unsolicited: "This is a very important undertaking in a field in which a committee of our faculty has been bogged down for some time. Frankly, we are seeking help and the corps of distinguished teachers comprising the staff persuades us that we may be able to secure some." An academic dean of the college of another great university furnished a remarkable report of a longstanding committee of his college, with findings almost identical with those which prompted the present N.Y.U.-Foundation offering. Expressions of admiration of this led him to say: "I cannot begin to tell you the endless hours that we have devoted to this subject during the past four or five

years. For various reasons, the chief of which was financial, we have not been able to put into effect the recommendations of the Science Committee. It is for this reason that we are particularly interested in the course you are sponsoring this year."

These and like expressions have come to us in letters from representative universities, general liberal arts colleges, technical schools, teachers institutes, theological seminaries, Catholic, Baptist, and other church-related colleges, Church College Boards, Ford scholars, and radio commentators, and in the form of news and editorial comment in journals of general national and international circulation.

What does this spontaneous and eager welcome mean?

The answer to this question in important part comes from the pages of *Science,* Nov. 2, 1951, pp. 471-472, devoted to the affairs of the American Association for the Advancement of Science. The Executive Committee has issued a statement, subsequently formally approved, from which we quote:

> . . . We have reached the stage where one over-all organization cannot effectively deal with the intensive and specialized interests of individual branches of science. The technical papers that present detailed results in chemistry, in physics, in mathematics, in zoology, etc., can more properly be presented before meetings sponsored and arranged by the appropriate professional groups.
>
> It is thus clear that the AAAS should not attempt to hold to a pattern of annual meetings that was natural and effective many years ago, but which is now outmoded.
>
> This is, in fact, only one aspect of an important general principle. In view of the present size and complexity of science, in view of the seriousness and importance of the relation of science to society, and in view of the unique inclusiveness of the AAAS, it seems clear that this organization should devote less of its energies to the more detailed and more isolated technical aspects of science, and devote more of its energies to broad problems that involve the whole of science, the relations of science to government, and indeed the relations of science to our society as a whole.
>
> This increased emphasis on broad problems should lead to new activities in wider fields, but it also requires a modification of what the AAAS tries to do with and for science. Thus it seems clear that a major present opportunity for the AAAS within science is to act, in all ways that promise useful results, as a synthesizing and unifying influence. As an obvious example, this indicates meetings at which one branch of science is interpreted to the other branches of science, meetings at which are stressed the inter-relations between the branches of science, meetings which cultivate borderline fields, and meetings at which the unifying theme would be central problems whose treatment requires the attack of several disciplines.
>
> This opportunity to try to "put science back together" seems so important that it may be wise to modify the existing statement . . . of the purpose of the AAAS to include more specific dedication to synthesizing activities. . . .

The program of the Foundation for Integrated Education in general, and the Course at N.Y.U. in particular, have come into being to assist and to expand this process, now being discussed by the AAAS. In particular our function is to help state the unifying principles so that humanities teachers can use them, without being subjected to the lag which now obtains in expressing scientific concepts in valid verbal and visual forms for general circulation.

To facilitate and accelerate what is now an admitted and urgent task, the Foundation invites the cooperation of individual teachers and faculty groups everywhere to share its materials with them, and for teachers and faculty to share their experiences—both problems met and gains made—with one another, through such services as we can together render in a program on the frontier of knowledge.

F. L. Kunz

A COOPERATIVE PROGRAM

During the current academic year, the Foundation has received numerous requests from college administrators and educators throughout the country for materials, advice, and assistance in the study of integrative programs. These requests quite uniformly point up the growing concern for the improvement of curricular offerings, especially in general studies. This concern is equalled by that for the necessity to convey to students the importance of the conceptual bases of moral and ethical individual and social action.

The Foundation interprets these requests as affording both an opportunity and a duty to share the experience which is being gained from the first course in integrative concepts, "The Frontier of Knowledge," which is currently being conducted in cooperation with New York University.

Accordingly, the Foundation is issuing an invitation to selected colleges throughout the country to join in a "Cooperative Program on the Frontier of Knowledge."

In this program, the Foundation offers to colleges, or their administratively-designated representatives, who desire a sustained cooperative relation, the materials related to and developed for the present course (i.e., the *Source Book,* supplementary data sheets, etc.). Also to be made avail-

able will be group subscriptions to MAIN CURRENTS in Modern Thought and bulk supplies as may be needed for use by faculty curriculum committees in the colleges.

A new feature of this service will also be the assistance of the Foundation to subscribing institutions in obtaining or developing visual-aid, radio program, and other materials for use in connection with their courses. Other resources will be made available as needed and as developed or discovered by the Foundation or the subscribing institutions.

In this program, the Foundation, further, is ready to arrange with colleges and universities a minimum annual cooperating subscription insuring that the services and items just enumerated will be available in addition to an advisory service by correspondence. If desired, these subscribing institutions may obtain consultative aid in course construction, faculty committee studies, and visitations on their campuses by Foundation representatives.

The Foundation will also be ready to negotiate with a few regionally distributed cooperating institutions for the co-conducting of workshops.

It is planned that cooperating institutions shall, for their part, contribute to the general pool of knowledge and experience in the expansion of this program. The Foundation, as the central secretariat of the program, will digest their reports of faculty committee findings, course outlines, curricular programs, experiences, and methodological developments, and will distribute them to all cooperating institutions in a *newsletter* to be issued from time to time.

Assurance that several important institutions are prepared to enter into this program with the Foundation prompts this announcement. It is hoped that there shall be at least 200 such subscribers by the opening of the academic year 1952-53.

For those educators or institutions to whom the purpose and the program have yet to be introduced, the publications of the Foundation (MAIN CURRENTS, Stillwater *Proceedings,* the *Source Book,* etc.) are, of course, available.

Subscribing colleges will be asked to pay modest fees for the services received. These will be scaled according to the type of service subscribed for. However, the maximum annual fee is not expected to exceed, for example, the cost of bringing a convocation speaker to a campus. This program is *not in any way a commercial venture* by the Foundation. Fees will cover only actual costs of the services. Naturally, the larger the number of subscribers, the lower will be the pro rata fees for any given type of service.

The Foundation is cognizant of the fiscal distress faced by all colleges. It is also aware that declining enrollments threaten most institutions. It is for these very reasons that this proposed program is deemed to be timely. It is entirely feasible, at small cost, to improve curricular offerings and to develop integrative programs *in the face of budgetary stringency.* Moreover, it is important that college administrators and faculties face the fact that their enrollment shrinkage is merely temporary. All things else being equal, the children who are now overcrowding the elementary schools of the nation will, in the mid-1960's, produce a stampede into college which will make the post-war tide of returned G.I.'s seem small in comparison.

The institutions of higher learning of this country are therefore faced with a double-edged problem of practical necessity as well as the problems arising from academic soul-searching, and the growing awareness that education must somehow teach more than facts. Ethics, morals, values, and a philosophy of life—by which free men everywhere may be enabled to win forward to the high destinies to which they seem to be called—must derive not only from a personal faith but, by strengthening through reason, become a persuasive social force.

It is with these facts in view, together with the awareness that the Foundation and its associates have contributions to make, that this program has been instituted.

H.W.C.

RADIO

Interviews with the Administrative Officer of the Foundation and five of the lecturers in the second term of the course, "The Frontier of Knowledge" will be recorded by the Radio University of the Voice of America for broadcasting on the world-wide network of "The Voice."

Mr. F. L. Kunz, Executive Officer of the Foundation, was interviewed over the air on Station WNYC, New York, on February 1. The same station made a recording of the first lecture of the second term of the course by Prof. Henry Margenau on February 5, with the possibility of rebroadcasting this, and probably other, lectures in the course at some later date.

The Foundation for Integrated Education will soon begin a 13-week series of broadcasts over Station WFAS, White Plains, N. Y., as its initial venture into radio. The series will employ material from the course, "The Frontier of Knowledge." Transcripts of the broadcasts will later be available to colleges subscribing to the cooperative program of the Foundation. When times of the broadcasts have been set, announcement will be sent to subscribers of MAIN CURRENTS who live in the area.

INTEGRATIVE CONCEPTS IN SCIENCE, PHILOSOPHY, AND EDUCATION

Some of the Major Integrative Concepts Presented In the Course, "The Frontier of Knowledge" . . .

Interest in the New York University course, "The Frontier of Knowledge: Integrative Concepts in Science, Philosophy, and Education," has been so generally expressed that we devote some pages of MAIN CURRENTS to compressed accounts of certain major aspects of the lectures. The form of expression here given to the arguments is (because of excessive reduction) not necessarily that of the speakers. Nor do these briefs communicate the sense of venture, often profoundly stirring, which accompanied many passages in delivery. We hope, nevertheless, that this report on representative content will convey something of the vigor and directness with which the lectures grappled with the conceptual essentials.

Verbatim lecture reports have been prepared approximately up to date, and will, under certain conditions, be made available as part of the cooperative program on the frontier of knowledge which the Foundation for Integrated Education is ready to offer. The program includes material linking lecture texts to the source book of supplementary reading and other facilities. Announcement will be made directly to cooperating colleges. F.L.K.

The first term of the course, "The Frontier of Knowledge: Integrative Concepts in Science, Philosophy, and Education," has been devoted to the contents and concepts of physics, geology, astronomy, biochemistry, and biology. No formula for integration has been offered or expected, but the students are being directed where to look for integrative principles, particularly those which help them toward relating life and energy in one whole, mutually adapted, system. The term has also supplied some acquaintance with method in science, the emphasis being placed on deductive-exact science. We summarize below important concepts and vistas which have been so far brought out in the lectures:

Lecture I. Introduction: Motivation and Need for Course, Dr. Henry Margenau, Higgins Professor of Physics and Natural Philosophy, Yale, and F. L. Kunz, Foundation for Integrated Education.

Professor Margenau, Chairman of the course: The objects to be achieved in the course are to disclose certain central principles in the exact sciences, to point out vistas leading from one field to another, and to remove the anachronistic couplings that exist between the various disciplines.

Mr. Kunz: The motivation of the course was recognition by the Foundation for Integrated Education and New York University officials of the need to distill from the "hard" sciences the concepts which lie behind the technologies and make them simple and comprehensive to the layman. If this were done, through the assistance of experts thoroughly familiar with frontier knowledge, these concepts could then be introduced into the humanities, and so become part of the whole cultural adventure. The thesis of the course is that the problem of integration cannot be solved until the key ideas of contemporary scientific thought are in general circulation.

Today we are in the same position of complete reorganization as was Europe when science arose and broke up its tight, integrated culture. Today we have a rather old-fashioned cosmology, a 19th century philosophy modified somewhat by 20th century developments. We have an economic system which is struggling to adjust itself to rapidly changing world conditions. And way out on the frontier, like the voyagers of the 15th century, there are men who are thinking of an entirely new universe, as new as was the round earth pictured in those early days. Here on the frontier, field theory is being studied, not only in physics but also in biology and sociology, and the whole universe is imagined as a compound of space and time. Just as the round world concept brought gold to Europe and so upset its economics, so these venturesome ideas are bringing to us a new wealth, nuclear energy, which may eventually supplant energy in the form of heat. Our world is on the verge of a tremendous and fundamental change, which will necessitate the reassembling of our background and our experience in terms of these new ideas.

Understanding the conceptual structures of East and West is vitally important in order to build a bridge between these divergent cultures.

Lecture II. Mechanism and Space-Time, Professor Margenau.

The view of classical mechanics may be summarized under three headings:

I. First and most fundamental is the view of matter which is characteristic of classical mechanics, and which may be reduced to the phrase, "to exist is to be material," or "to be material is to exist." All material things, in this classical view, exist in a really tangible fashion. Matter is endowed with two properties: It is space-filling and impenetrable. Two particles of matter do not in-

terpenetrate but repel each other. All matter can be analyzed into what is called mass points, the smallest units of matter which can still be considered to have mass.

II. The second characteristic of classical mechanics is a special view concerning the nature of force. It supposes that force is a push or a pull. Forces are transmitted only by material objects, in fact, by contact of material objects.

III. This second concept leads directly to the third, for if force is a push or pull applied by contact, obviously there must be a medium through which the force can be propagated. So the third principle has to do with the medium which fills space. In any theory of nature, the problem of how a force travels from one point of space to another must be considered. When classical mechanics committed itself to the view that the nature of force was represented by a push or a pull, it was driven to assume a medium which was space-filling and material, through which the push-pull effects could operate. That medium was called the ether.

Recent work in physics, particularly the theories of Einstein and such experiments as that of Michelson and Morley have had far-reaching effects on these classical theories. The experimental evidence necessitates in some cases a choice of theories which go against common sense. Science has in several notable cases been forced to discard common sense ideas of stability and mass as well as preconceived ideas of an ether in order to adhere to its innate convictions and maintain the internal consistency of its formalism.

What does this mean with respect to current thought and the latest findings of science, such as relativity? It means that we are no longer permitted to say that space is filled with a material ether. The ether now has been replaced by a structural field, discussable in terms of symmetry—a field whose essence is captured in mathematical formulae. The ether is indeed ethereal in the original sense of the word.

One of the main points that I want to leave with you is that physical existence is not limited to what the eye can see. When this statement is made, not by the poet or philosopher or theologian, but by the physicist—one of a class generally said to believe only in what can be seen or heard or smelled—it ought to be impressive. Today when the physicist hears about strange "fields" in psychology, biology, and even parapsychology, he is not likely to be the one to cast ridicule upon such things, for he was the first to prove that abstract ideas can be important. He insists on care and honesty of observation and on consistency of theory; he does not demand explanations in terms of moving masses.

The second point I want to impress upon you is that truth often makes a mockery of common sense. d'Alembert's encouragement is even more applicable today than when it was first given: "Go ahead, even though at first your scientific results seem to be unbelievable. Faith will come." He also said truly that common sense never *leads* an advance in science. Common sense is but the residue of scientific discovery. That which has finally come to be common knowledge always lags behind science, because of the defects in education. There is no reason, however, why this should continue to be the case. Everybody should know that the old mechanistic ideas are today an anachronism. The spirit of modern science can and should be taught, not only at the college level, but earlier as well. When this is accomplished, common knowledge may become valid knowledge, common sense may be real sense.

Lecture III. The Breakdown of Mechanism, the World of Quanta, Dr. Margenau.

(The development of the idea of matter was traced from Greek and Indian philosophers through the most recent findings in physics.)

What is an atomic particle, such as an electron? Three kinds of answers can be given to this question, all of which are in reasonable harmony with the experimental facts:

1. The electron is *sometimes* a particle and sometimes a wave. Someone popularized this thesis by saying that the electron is a particle on Mondays, Wednesdays and Fridays and a wave on Tuesdays, Thursdays and Saturdays. If this were true, reality would be ultimately ambiguous, and scientists are not willing to accept this verdict.

2. A fundamental particle, an electron, is *both* a particle and a wave. That is to say, it has particle aspects and it has wave aspects. This idea was revived in modern physics, although it originated with Newton, who is frequently said to be the protagonist for the corpuscular nature of light. That is a simplification. Newton exemplified his idea of light in this way: Light is like a row of ducks. The ducks are material, like particles. This row of ducks moves along on the surface of an originally quiescent pond, and as it moves, waves are set up. As these waves move faster than the ducks, they overtake the ducks, and make them bob up and down. This Newtonian theory of light has recently been applied to the fundamental particle of the atom, and the assertion made that it is both a wave and a particle, somehow mixed together. Here again want of time forces me to be dogmatic. It can be shown that this is not the nature of light, or of electrons. One can get into serious contradictions by making the assertion that electrons can be both particles and waves.

What then remains?

3. The third possibility, an obvious one, has not been discussed very frequently in science. It is

that an electron is neither a particle nor a wave. Why indeed should it be? Is it necessary for us intuitively to assign attributes to things as small as an atom, which cannot be seen? An electron is a thousand times smaller than a wave of visible light. Only things which are much bigger than a light wave can be said to have color, which arises from the reflection of light waves. Since an electron is too small to reflect a light wave, it is fairly clear that we must divest ourselves of the habit of imparting color to an electron. The color of an electron is about as real and important as the color of an elephant's egg, if an elephant did lay eggs—but it doesn't.

And what can we say about the position of the electron? Since an electron is so small that it can't be seen, should we visualize it as having position or shape? Perhaps we are here taken back to the question of primary and secondary qualities, which arose in Greek science and philosophy, and was revived in Galileo's day. Position, shape, corpuscular or wave nature may all fall in the general category of properties which may not be directly assigned to electrons.

Further consideration leads inevitably to the conclusion that there is indeed no position to be assigned in general to atomic particles. Although this conclusion may at first seem unpalatable, it takes on a degree of reasonableness when it is viewed against a larger background of science. In the first place, we have already indicated that there is no reason why particles smaller than a light wave should have color or other visual, pictorable attributes.

A similar situation obtains in other fields, such as psychology. Psychology deals with man, who has numerous qualities, or attributes, which can be measured. For instance, as man is capable of being angry, anger is, therefore, a property of man. But it is not an invariable property; for man is sometimes angry, sometimes not. I have chosen to call such attributes latent observables, in contradistinction to possessed observables.

Through quantum mechanics, modern physics has joined the ranks of sciences which have to deal with latent observables. Physics has been able to do this without diminishing its predictive power, by fashioning its theory after the statistical model. In this way physics has taken on some of the interesting characteristics of psychology. Biology also is in the some position.

Lecture IV. Directives Implicit in the Structure of the Earth, Dr. Kirtley F. Mather, Professor of Geology, Harvard.

It has become apparent that the structure of the earth, both in the large and in minutest detail, is the result of orderly processes operating in a rational manner. Firmly established in geologic lore is the principle of unformitarianism; all present or past features of the earth are explainable in terms of processes now operating somewhere in the same way, though not necessarily at the same speed, as they have been doing since the earth came into existence. Without exception each problem with which the geologist is challenged becomes amenable to solution in terms of the processes now operating somewhere in exactly the same way as they operated here in the past to produce the observed result. Geologists cannot help but be convinced that ours is "a world of law and order."

We find it essential to divide the natural resources of the earth into two major categories. The first of these includes those that are renewable; "man's annual income." These are being supplied as rapidly as, if not more rapidly than, we use them. The best example of such renewable resources is water power. The second category is the non-renewable resources, nature's stored capital. All of the mineral resources of the earth, with possibly one or two minor exceptions, are in this category. Of the non-renewable resources, every one of the essential mineral resources required in this age of technology is available in the outer shell of the earth thousands of times our present annual use. There are certain important exceptions, but for each of these a substitute is already known.

Ours is a world of potential abundance. Yet from this survey of potential mineral resources come two directives which we should heed. The first of these, as said, is that these are non-renewable, and inevitably, if present trends continue and men keep extracting mineral fuel and metalliferous ores from the earth, there will come a day when they will be used up. It therefore behooves us to adopt a policy of shifting the basis of our economy from our present reliance upon nature's stored capital to a future dependence upon man's annual income.

The second directive is an imperative right now, however. My statements concerning the abundance of nature's stored capital are based upon world surveys. No nation covers a sufficient variety of geological structures and includes enough different climatic conditions to permit its citizens to secure within their own territories adequate supplies of all the requisites for what we are pleased to call civilized living.

In our times, this fact of inescapable interdependence becomes ever more unmistakable. The structure and the geological history of our earth are such that it is far better designed for occupation by human beings who arrange for a free flow of raw materials and finished products of goods and services, of ideas and ideals, the world around, than it is for habitation by human beings who insist upon building barriers around even so large an area as that of an entire continent.

There is a directive towards world organization established in the very structure of the earth. If we hope to utilize wisely the rich resources of our bountiful world, some such organization is impera-

tive, that these resources, abundant enough for all, but locally concentrated and widely scattered, may be available for all. Anyone who makes himself familiar with the processes of change becomes deeply aware of the necessity for man to adjust his ways of life to the ways of nature.

Lecture V. The Stars, Their Natures and Behavior, Dr. Harlow Shapley, Director, Harvard Observatory, Harvard University.

The major advances in astronomy during the past half century are:

1. The quantum theory of radiation, and its consequences.
2. Star streaming and galactic rotation.
3. Stellar temperatures, the exploration of stellar interiors and energy sources.
4. Development of photometric methods of distance measurement with demonstration of the eccentric location of the solar system.
5. Identification of the Magellanic Clouds and spiral nebulae as galaxies of stars.
6. Relativity, theory and practice—that is, in a way, the expanding universe.
7. The "boom" in instrumental power and diversity.

The stars can remind us of an integrating factor, namely that organizational tendency is everywhere. Throughout nature there is clustering, grouping societies at all levels. Societies can be a swarm of bees, or a particular class of loose organization like the Borough of Manhattan. Go up in organizations through the biological scale and the human scale to astronomical reaches and we see that the earth and its moon constitute organization on a planetary scale. Of course we don't stop there. We go on to the sun with its system of planets, and the sun is a member of a group of stars, and groups of stars can be of all sizes.

Why does this organization tendency prevail? While we know that gravitational operation tends to hold things together, there are also other operations such as radiation which tend to keep things apart and disperse groupings.

It has had a tremendous effect upon me to realize that in globular clusters of stars you have perhaps 50,000 stars operating smoothly in one great group. The most appealing thing is that we don't know how they become clusters and maintain such beautiful symmetry. But we do think we know what their future will be. Thanks to the mother of sciences, mathematics, we can calculate the future of a cluster.

There are globular clusters of different kinds and galaxies which are irregular, for everything in the universe is not smooth yet. Why is this? We believe that the universe is still young. If one will give such an irregular system a million billion years experience in motion, it will develop into a large smooth system or a spheroidal system.

'*Lecture VI. Summary (Methodology of Physical Science), Dr. Margenau.*

Previous lectures dealt with recent discoveries in the physical sciences. The present discussion concerns the method by which these discoveries have been accomplished. It draws attention to the age-old counter-play between experience and reason, and raises questions, among others, like the following:

Why does nature conform to reason?

Why does the stone describe a perfect parabola as it falls?

Why does an electron satisfy simple differential equations?

Why does the universe expand in accordance with a linear law?

In the introduction several historical answers to these questions were reviewed: notably Plato's theory of reminiscences; St. Thomas' doctrine of a perfect God who necessarily gave men a reason conformable to the facts of nature; Leibnitz' theory of a pre-stabilized harmony; Kant's synthetic a priori; Mach's positivism. It is widely believed that the scientist or philosopher who raises the question concerning the roles of experience and reason today is trying to revive a corpse. That this is an erroneous contention was demonstrated by two examples here briefly reviewed.

1. An empiricist who believes that everything of interest to science is yielded by observation, analyzes a physical object such as this desk before me. He decomposes it into smaller and smaller parts, ending up with protons, neutrons, and electrons. These latter entities, however, are known to possess many qualities not given in perception, indeed qualities which defy the dictates of common sense. Their nature is in a true sense abstract and non-observable. It appears then that a desk, which by hypothesis is wholly observable by our senses, is made up of entities not wholly given in sensation.

2. Recent theories of astronomy rely greatly on principles which derive their validity, not from empirical facts but from certain pre-conceptions concerning the simplicity of nature. One such theory (advanced by Jordan) was discussed. Astronomy yields the following list of numerical constants:

1.	**Velocity of light:**	$C = 3 \times 10^{10}$ cm/sec.	(LT^{-1})
2.	**Gravitational constant:**	$K = \frac{8\pi}{c^2} G = 1.85 \times 10^{-27}$	(LM^{-1})
3.	**Age of Universe:**	$t = 4 \times 10^9$ years $\cong 10^{17}$ sec.	(T)
4.	**Cosmic density of matter:**	$\rho = 10^{-30}$	(ML^{-3})
5.	**Radius of universe:**	$R \cong 10^{27}$ cm	(L)
6.	**Hubble constant:**	$\alpha = \frac{c\Delta\lambda}{r\lambda} \cong 10^{-17}$	(T^{-1})

From these constants, all of which are non-numeric and therefore have units, the following three dimensionless constants can be formed:

R/ct; αt; ρkc^2t^2

Strangely the values of these three are in the neighborhood of unity! Is this a mere coincidence? Many scientists answer no, convinced that regularities of this sort have their roots deep in the nature of things, that our universe is a cosmos and not chaos. If the assumption is made that these three constants are indeed one, have been one in the past, and will retain this value in the future, very amazing cosmologies result. In one of them the laws of nature change in time, the universe had its origin four billion years ago, and stars are continually created out of nothing.

Scientists are willing to base such radical speculations upon the conviction that nature is essentially simple and that physical theory must have aesthetic appeal.

After this introduction, which conferred particular emphasis upon the interplay of reason and observation in modern science, a theory of method was developed.* In conclusion the following quotation from Eddington was given:

"Man found a footprint on the shore of the unknown;
Lo and behold! The footprint was to be his own."

Lecture VII. The Chemistry of Living Matter, Dr. Joseph S. Fruton, Professor of Biochemistry, Yale.

The problem before us this evening is simply this: Can one describe the phenomena of life in the language that we have come to develop through our knowledge of inanimate nature? In other words, can we describe the phenomena of life in the language of chemistry and physics?

The living cell is still the only known agent for the manufacture of proteins, and in this deficiency of present-day chemistry lies one of the refuges of the modern vitalist. Let me remind you, however, that only 120 years separate us from Wohler's achievement in synthesizing urea; it would be a rash man who would say that even the artificial synthesis of a naturally occurring protein may not come in the century ahead.

The fact does remain, however, that in the phenomenon of protein synthesis in living cells we have an expression of the extraordinary chemical capacities of living matter. It was natural that, in the early days of scientific chemistry, and even before, this should have been recognized and taken as an expression of some vital force not observed in inanimate matter. Even in the case of reactions that could successfully be imitated in the flasks and test-tubes of the chemist, he had to boil or treat with powerful and corrosive chemical reagents, while the living organism acted at the moderate temperature and essential neutrality of its internal environment.

The search for the material basis of life has not yet satisfied the objections of the vitalist philosophy. The deficiencies of the methods of the chemist are only too apparent in his inability to synthesize the basic chemical units of living matter, the proteins; and his advance in the understanding of the action of enzymes depends on a deeper penetration into the problem of the structure of proteins. It is also clear that the biochemist has achieved only a fragmentary view of the chemical architecture of cells and the organization of chemical events that occur in them. But in stressing what is unknown, it is well to remember also that biochemists have been on the job for a relatively short time. The doctrine of vitalism is at least 23 centuries old, and scientific biochemistry began only a century and a half ago. What is more, the experimental scientist in that brief time has been able to give to the question "What is life?" increasing precision and thus increased the chances of ultimately providing an answer. What the final answer will be, or whether it will be attained at all, are themselves questions to which no answer can be given today. It is perhaps this very uncertainty that makes the pursuit of biochemistry the enjoyable adventure it is.

Lecture VIII. The Living Mechanism, Dr. William Seifriz, Professor of Botany, University of Pennsylvania.

(Dr. Seifriz showed remarkable microphotography in motion pictures of the normal and the disturbed activity of protoplasm in slime molds.)

I suppose everyone wants to know whether we are any nearer an answer to the question, what is life? I cannot say very much of it, nor can anyone, but this need not discourage us. Research will progress unabated. As for the question, what is life?, we can always theorize and ask ourselves many other questions, such as is there one, ultimate, living substance, or is no one substance in protoplasm more alive than another? The water in protoplasm, which makes up 65 to 75% of it, is not alive; the salts, sugars, and fats are not in themselves alive. Then is there any *one* living substance, other than the protoplasmic complex as a whole? If there is, it is surely protein in nature. But there is no reason to believe that there is one ultimate living substance. Then you will say, well, if there is no one living substance in protoplasm, what is alive about it? My only answer to this is *structure*, the way protoplasm is put together.

I might compare protoplasm to a clock. When the springs and sprocket wheels which make a clock lie on the table in a heap, there is no clock,

*H. Margenau, *The Nature of Physical Reality*, McGraw-Hill, 1950.
See also *The Nature of Concepts, Their Interdependence and Role in Social Structure*, Proceedings of the Stillwater Conference, conducted by The Foundation for Integrated Education, published by Oklahoma A. and M. College, 1950. May be ordered from the Foundation.

but when they are put together properly, the correct number of them, in perfect alignment, a clock results. I mentioned such a clock to an audience in which there was a philosopher, and he said that I had built a very lovely clock, but I had forgotten to wind it. This means that we must add something else to structure, some form of energy such as we do when we wind a clock or swing a pendulum. What this "something else" is in the case of living protoplasm became the subject of quite a discussion.

Though I firmly believe in the chemical and physical approach to biological problems, I still do not believe that we shall ever put that living machine together.

Lecture IX. The Path of Life Through Geologic Time, Dr. Mather.

(The grand strategy of evolution was surveyed in terms of palaeontology. Dr. Mather's photographs documented most of the major principles of evolution as seen chiefly in the higher animals. He included treatment of effects of the biological environment upon specific organisms, and made applications to human society.)

An animal species or genus or family has its relatively brief day on the stage of life and then must make its exit. But there are two exit doors. One exit, that through which passed the trilobites, the dinosaurs, the flying dragons, and many other creatures, is a door that leads to oblivion. The other exit leads to higher achievement. The three-toed horse became extinct in order that the one-toed horse might follow in its foot-prints and advance beyond anything that it itself had attained.

That thought is especially pertinent as we turn our attention at last toward mankind. We human beings are in the stream of life, a part of the procession, and some of the things that we learn from other creatures ought to help us, because we are subject to precisely the same principles of adjustment and relationship.

As we turn from the inspection of the panorama of life to its interpretation, two or three important principles seem to loom very large. The first: Whatever the nature of the administration responsible for the creative process, it has operated in an experimental way. There seems to have been something comparable to the method of the modern man of science, as various experiments were tried under different conditions and with diverse materials. The second: Whatever may be the nature and purposes of the administration, it is imperative that every type of creature make adequate adjustment to the sum total of the conditions in the environment, if that type of life is to continue.

In the geologic past, there have been many episodes of environmental change. New lands have emerged to bridge the gaps between continents; old connections have been submerged. Climates have changed from cold and wet to hot and dry. Animals or plants that were adequately adjusted and therefore relatively secure in some particular time or place became inadequate in the same place at another time because of changes in the environment to which they were unable to make adjustments before it was too late. What has happened in the past may happen again in the future.

Fortunately, the human species is possessed of great flexibility. In part, this is due to our rather primitive physical characteristics as mammals. We still have five fingers, five toes—the primitive number. To a large extent, we are able to adjust ourselves to any physical conditions in our environment because of our intellectual resources. The human mind is capable of seeing situations as they develop and providing the necessary materials—insulated shelters, air-conditioned houses, for example—that permit us to live as we choose in Arctic wastes or Sahara deserts. We have "drawn the teeth" of the physical environment.

But the one element in our environment which is most demanding and to which we have not yet made adequate adjustment, is ourselves. We have not yet learned how to adjust the life of a group to the environmental factor provided by the presence of other groups of human beings, near or far away. That is the insistent problem of the present day. Just as certain creatures of the past, when weighed in the balances, were found wanting and were discarded, so there is a possibility that we of the present may likewise be found wanting when tested on the cosmic scales. Our challenge is one of adjustment to our environment, but this time it is adjustment to our human environment. To meet that challenge involves something quite other than ability to manufacture gadgets, or implements, or munitions. It involves the human spirit, and only as the members of the human species discover each for himself a satisfactory spiritual source, impulse, and directive, can we expect or even hope to make satisfactory adjustments to the new conditions of this new cosmopolitan age, in which there are no barriers between the many members of the one far-flung human family.

Lecture X. Symmetry in Living Nature, Mr. Kunz.

(The nature and contribution of deductive mathematical biology in the understanding of the life process was reviewed. Mr. Kunz used the concept of symmetry to emphasize the persistence of order amid variety. He discussed the possibility of an over-all geometry for biological formal orders, based on the regular convex polyhedra and polytopes.)

What then are we to do in our present study to end the bifurcation in the natural sciences, between physics and biology? Professor Margenau has earlier in our study given us cause to believe that we no longer need to be resigned to a state of disintegration, when he pointed out the physicist's treat-

ment of some of the phenomena of the microcosmic world can be applied to genetical phenomena. In this was a hint that there may be a third approach to biology, agreeable to the new physics.

Our present business is to identify this third alternative, what is called mathematical — and especially deductive mathematical — biology. In an organized form it is a relatively recent development. Much of what I have to say will, therefore, constitute actually a *prima facie* case for new empirical work and fresh research into biological literature.

In living organization — which many biologists hold is the *essential* reality, physically displayed in the living creature, where it is joined with psychical activity—symmetry and proportion are not only commonplace, but are either universal in fact, or implicit in description.

Precise study of symmetry, and the general applications of mathematics to nature, enable us to address ourselves to the old problem of mechanism and vitalism in a new way. Professor Margenau has already pointed out that since mechanism itself has declined, the problem (if there is one) certainly must be stated quite differently.

Living orders are expressed in matter, and implemented by energy. Hence we are called upon to ask how the orders and symmetries of non-living material are related to those of the living, if we are to have a consistent doctrine for all of natural science.

In pursuing this subject—a possible geometry for the life process—we are, in effect, seeking for biology a space-time metric such as is now familiar in studies of electromagnetic, gravitational, and thermal systems, considered as fields or continua. In the biological organism the field may be conceived as being displayed in the activity and disposition of cells, tissues, and organs, as if they were test objects, as iron-filings are test objects for a magnetic field. The metric sought must be self-consistent and must be justified by natural evidence. It must unite matter and life in one rational whole.

Lecture XI. Environmental Effects on Living Organisms, Dr. Paul B. Sears, Professor of Botany, Yale.

The scientist, like everybody else, operates very largely on the basis of intuition and aesthetic impulse. He is a scientist because he wants to be. More than that, he is moved by a profound faith that the universe of experience is a consistent universe, that it hangs together. Without that conviction, he would not have the courage to go ahead and do what he does.

In addition to this faith and the confidence he feels in the things he senses, he takes the liberty of reaching beyond these things and drawing certain deductions or inferences concerning things that he cannot see directly. He cannot always wait for all the information he needs in order to go on from where he is and build up a completely logical structure, so he must begin where he can.

The work in this particular course is to my notion one of the most urgent and pressing lines of effort in American education today. I run up against the problems with which it deals constantly in my work with the conservation of natural resources. As a botanist and ecologist, it has been my business to study plants and animals in their natural surroundings. One presently discovers how inseparably man is tied up in this whole picture, and how dependent he is on natural resources. But in conservation of natural resources we can do relatively little until people have some kind of a rational, balanced picture of the universe of which we are a part.

We cannot live apart from the material world, since every breath we take is interchangeable material in the physical world around us. Everything that goes in must go out and must be accounted for. It has become impossible, except as a matter of convenience, to think of a living body in any sense apart from the physical, non-living world around us. The materials which are elaborated by living plants, and upon which we all depend for food and fuel, are broken down step by step before they finally get back to the raw materials of the earth and the air from which they came. Each of these steps affords an opportunity for an organism or a group of organisms to make its living out of the situation as this material is broken down from a plant or animal form. We speak technically of these opportunities as niches.

An organism finds its niche, and to find its niche, it must in the long run perform some service. It must discharge some useful or innocuous role in relation to the community, or it is wiped out. It must make itself sufficiently useful and effective so that it adds to the effectiveness of the whole community. We see then that all over the universe there is no such thing as a solitary plant or animal. And we, more than almost any other organism, are dependent upon the rest of nature. We are newcomers into a very highly specialized world and we are specialized for that kind of world. We must make our peace with it or we will not get along.

Lecture XII. Heredity and Environment, Dr. Th. Dobzhansky, Professor of Zoology, Columbia.

The process of evolution has taken place under the influence of causes which are still operating at our time level and which happen to make sense to our reasoning facilities.

As shown first by Darwin, approximately ninety years ago, the prime mover of evolution is the process of adaptation to the environment. Living organisms are as diverse as they are because the environments which exist in the world are also tremendously diversified. Each living organism occupies in the economy of nature a certain ecological niche, a certain vacancy which must be filled by an organism of a given kind. Life is con-

sequently at the same time a process autonomous, *independent* of the environment (it holds its own, it preserves its identity); and *dependent* on the environment (gradually changing and evolving in accord with the requirements of the environment). These two aspects of life—its autonomy and its dependence on the environment—are probably among the most fundamental phenomena of biology.

Perhaps one of the major attainments of biology in the 20th century is the demonstration that the basic life processes occur on the molecular scale. In other words, dependence as well as independence from the environment are, in the last analysis, molecular phenomena, which occur essentially in the form of reproduction of the genes.

It is very probable that the heredity—the genes—are among the chemically most active constituents of the organisms. They are in a constant interaction with the environment, interaction which tends toward the transformation of all susceptible parts of the environment into itself. We can say, in the most general way, that every gene tends to transform all the susceptible environment into copies of itself.

If the living system is placed in a variety of environments, several possibilities present themselves: (1) The gene is so changed that it no longer reproduces itself but is lost. (2) In a great majority of cases, if the gene reproduction does take place, it takes place accurately—a faithful copy is synthesized. What alters is the by-product of the gene synthesis.

By stability of heredity we mean the essentially cyclic nature of the fundamental process. The gene either reproduces faithfully or not at all—with the rare exception of mutations.

The stability of heredity, its independence from the environment, is a very peculiar and special thing: it is a stability which is inherent in the cyclic nature of the process, and which at the same time permits life to preserve its essential autonomy from the environment and to be modified by it. One of the most widespread fallacies which can be found over and over again is the contrast, the antithesis between hereditary traits and environmental traits. Particularly among medical men one encounters the idea that if something is hereditary, it is not susceptible to environmental modification; and if something depends on the environment, it is not hereditary. This is thoroughly fallacious. Hereditary traits are modified by the environment, and traits which are modified by the environment are hereditary because what heredity determines is not this or that trait, but the response to the environment. What is really important is the response to the environment with respect to its influence on the fitness of the organism.

The arts of medicine, teaching, and education, from the standpoint of genetics try to invent environments to which the existing norms of reaction respond by most favorable, by most adaptive possible developmental outcomes; they try, by a process of reasoning or trial and error, to invent new environments to exploit the most favorable reactive capabilities of the existing hereditary constitutions.

Lecture XIII, Dr. Ashley Montagu, Professor of Anthropology, Rutgers University.

I am not going to give you an account of the principles of evolution, but rather a critique of evolution in the light of the scientific findings of not only biology but also biochemistry, physics, anthropology, etc. The advances in the biological sciences and particularly in genetics have been such as to require a modification of Darwin's original theory, formulated in the 19th century. These advances also have implications for the integrative aspects of knowledge.

It is important to discuss the problem in terms of historical developments, especially in the framework of the 19th century social milieu. The Darwinian theory is a beautiful example of the development of ideas out of a particular social matrix. It is commonly thought that the theory of evolution conditioned the social thinking of the latter half of the 19th and first half of the 20th century. The truth is, in fact, the converse. The biological thinking of Darwin was actually determined by the social thought of his own and the preceeding day.

In the latter part of the 18th century Joseph Townshend, thinking on the problem of the increasing number of the poor, published a small pamphlet, "A Dissertation on the Poor Laws by a Well Wisher of Mankind." This influenced Thomas Malthus in 1798 to publish his famous essay on the principle of population, in which he set up the laws and theories that the population increased in geometric ratio and the food supply in arithmetic ratio. He also said that there must be certain natural checks on population: famine, disease, and war. Malthus and Townshend were social thinkers conditioned by the framework of the society in which they were living.

Darwin, in his *Origin of Species,* published in 1859, said that he applied the principles of Malthus to the whole continuum of life. He emphasized that there is in nature a more or less continuous "struggle for existence" in which organisms compete with one another. Competition is the operative word throughout the writings of Darwin and the Darwinists. In one place in the book Darwin says that he uses the phrase, "struggle for existence," in a metaphorical sense and that he does not mean that there is always competition in the sense in which competition is ordinarily understood. But throughout he uses competition in terms of hostility and combativeness. These views of Darwin influenced very greatly the thought of biologists and social thinkers, so that our literature is now full of Darwinian stereotyped phrases.

Darwin put the whole theory of evolution out of focus. So far as it went, it was largely sound, but it was unsound to the extent to which it overemphasized the principle of competition to the exclusion of other principles.

Darwin neglected what may be called the principle of differential fertility, that those organisms which have the adaptable fitness called for by the environment in which they find themselves will leave a greater progeny behind them than those which do not have this adaptable fitness.

Also, he wholly neglected to recognize the existence of the principle of cooperation in evolution. This principle is becoming, in the second half of the 20th century, more and more familiar to some biologists and actually is being checked, investigated, and verified. The principle says that insofar as organisms cooperate with one another, they confer survival benefits upon each other. These organisms are more likely to survive as individuals and as a group than organisms which do not cooperate with one another but struggle against each other to obtain such benefits from the environment as would accrue to them alone and would not be shared with other organisms.

Cooperation is not opposed to competition nor does the principle work in nature to the exclusion of competition. But competition and cooperation both occur as processes in nature, and the Darwinian biologists never properly evaluated the respective parts that they play.

We can check the validity of these facts by experiments in which certain organisms are put into a competitive environment or state, and similar organisms, genetically as identical as possible, into an environment in which the cooperative factors dominate. We observe invariably that the cooperators have an enormous advantage over the competitors. Experiments can be set up with psychological or with physiological conditions.

Preservation is an operative word which Darwin neglected to see in the fullness of its meaning. Preservation is made possible only by means of the cooperation of the group in which genetic changes have occurred. If cooperation does not occur in the group, the group cannot possibly survive. Cooperation thus becomes a highly significant factor in the evolutionary process. The more we learn about the factors as they occur in nature, the more it seems that cooperation is dominately the factor operative in the evolutionary process and that competition is a factor secondary in importance. Where competition can be and is replaced by the cooperative process, evolution proceeds at a more rapid rate. These are matters which can all be put, and in part have been put, to experimental test.

The biological principles of Darwin were translated into the social framework, and the same competitive "struggle for existence" was seen as operative in the relations of human beings and groups. This idea, social Darwinism, was accepted with open arms by thinkers of the day, particularly in the United States. It seemed to give the scientific basis for rugged individualism.

I think that we are now on the threshold of the corrective to this misconception of the evolutionary process, but there is little enough time to apply this corrective. In the light of recent findings, it is up to us now to take the sap out of Homo sapiens and put back what wisdom we can gather.

Lecture XIV. Cell and Psyche, Dr. Edmund W. Sinnott, Dean, Graduate School, Yale.

The science of biology can be integrated with psychology above as well as with physics and chemistry below. The major problem centers in protoplasm.

Regulation in organisms both in developmental and vital activities seems to be goal-directed. The blastula is trying to grow into a chicken. My thesis is that biological organization, developmental and physiological activities, and psychical activities are fundamentally the same thing. Biology looks at these activities objectively; psychology subjectively, as purpose. The developmental standard is set up in the organism, and the same control that guides its behavior ultimately leads to purpose in psychological phenomena.

This theory implies neither mechanism nor teleology, but says that both are different aspects of the same thing. The answer will ultimately depend upon what causes organization.

The big gap is how the genes control development. A single gene has a whole repertoire of roles and changes in development. A purpose yet to be realized may be said to be in the egg. But there must be some overall director, like a concert master with a baton.

Each of us is inside a living thing, and we can learn a lot about it from this. Introspection and intuition ought not to be frowned upon. Intuition is not in some ways rational, but it gives us clues to the universe. The ratiocination of science and the intuition of the poet and seer are both approaches to truth.

Haldane and Sullivan say that organization is fundamental and physics and chemistry must be understood in terms of organization. Biology is much more complex than physics, and we are missing some of the fundamentals. It may be that some of the concepts of extra-sensory perception can be useful. Although evidence for the existence of this phenomenon is well authenticated, we put it aside because we cannot yet imagine a mechanism to explain it.

Science is at its best in analysis, not in synthesis. The big problems in both biology and psychology are in synthesis. Let us not lock up the future in our present concepts.

Lecture XV. Review and Discussion, Dr. F. S. C. Northrop, Sterling Professor of Law and Natural Philosophy, Yale.

Professor Collingswood of Oxford once distinguished science from philosophy in this manner: Science is that discipline which talks about facts. Philosophy is concerned with the concepts that the scientist uses when he talks about facts. Whereas the facts are infinite in number, the concepts used to describe the facts can be smaller in number.

Thus, by stepping back and directing attention to the words used to describe the facts, we move a little nearer unity and integration. But having done this, we must proceed to analysis. When we consider the concepts used by different people in different fields of knowledge, we have to ask ourselves where these concepts find their meanings. We find that there are just two places where concepts can find meanings.

One place is in the immediacy of experience itself, in what Professor Margenau has called the p-plane of knowledge, this color, this noise, this odor. The only other place in which concepts can find meaning is in those facts and relations which are inferred from immediacy.

Scientific method at bottom is nothing more than a way of tying concepts to their meanings in an exact manner, so that theories can have meanings even if they are false, and so that theories which are true can be verified. Thus we find the key to the integration of the overwhelming complexity and diversity of man's knowledge if we concentrate attention on the methods science has devised for giving words exact meanings and for verifying theories built out of those meanings in those cases in which the theories refer to what is not given with immediacy. Our concepts refer to immediacy for verification; the source of their meaning is automatically the source of their verification.

What knowledge would be left if we were restricted to the concepts that we use in knowledge of immediacy to pure fact? By pure fact I mean the raw data of immediacy before we conceptualize it. Different cultures in the world arise because people in different places on the surface of the earth conceptualize the raw data of experience in diverse ways.

But nonetheless, if we study any one of the Asian cultures, whether it be Confucian Chinese, Buddhist, Hindu, or Taoist, or if we consult the modern empirical philosophers, Berkeley, Hume, and William James, we find on the whole, with one exception, roughly the same agreement on empirical immediacy in both the Orient and in the West.

What we have given with immediacy is much less than one might suppose. It is not an object, as a three dimensional material object, existing when we are not looking at it. Experiences in Asia and Bishop Berkeley's empiricism in the West make it clear to us that all we have given with empirical immediacy is what our senses convey, and our senses do not convey a three dimensional material object. The sense of sight conveys nothing but a colored shape. The sense of sound conveys noise. The sense of taste conveys a flavor, and the sense of smell an odor. Not one of these objects is a material object. Each one of them is an aesthetic quality. You cannot describe that noise to anybody who has not heard it. You cannot describe "blue" to anybody who has not seen blue. All these objects are given with immediacy.

This continuum of pure fact is what Professor Margenau calls the p-plane, and what I in *The Meeting of East and West* call the aesthetic component. Concepts in this field are concepts by intuition in the Oriental and Einsteinian sense of that which is given by pure fact with immediacy, not intuition of the sense of a woman's hunch. The philosophy in the West which restricts itself to this is now known as "positivism." If positivism deals with the whole truth, there are no concepts in any domain of human knowledge that do not come back to pure fact for their immediacy. All concepts would be concepts by intuition. In the second lecture of this course, Professor Margenau showed that this is not true. It is important for us to see that it is with this that science begins, however. The first stage of science, even though it goes on to something else, tends to describe its material in concepts of this form.

Berkeley, Hume, and the philosophers of the Orient saw that any sensed object is not independent of the observer. The essence of these objects consists in their being perceived. This may be seen clearer with respect to shape. The table that I see from this angle is different from the table which you see from your viewpoint. Sensed objects are not public objects. They look public, but they are relative to the perceiver. Knowledge given with immediacy is relative.

The Orient, in its best thinkers, reached the conclusion that the only object which is the same for all observers is Brahman, the continuum which is the same in me as in you. In the philosophy of Lao-tse, this is called Tao; in Buddhism, Nirvana.

If the West had stayed with this point of view, I believe that we would never have developed technology. In Western science from the Greeks to the present, it is affirmed that there are scientific objects common to all perceivers. Therefore in Western science, reality is given by determinate propositions. Determinate objects are given by determinate laws which are the same for everybody.

This originated with the Greeks. Democritus asserted that there is a factor in knowledge not given with immediacy. He drew the distinction between the sensed world and the real world. The entities, such as atoms, to which Democritus referred are terms in a serial order. The atom of Democritus was not a billiard ball. His atom satis-

fied the postulates which he had set up. Similarly, Lorentz used the term "electron" as a variable which satisfied a particular set of postulates. The meaning is given in the postulates. And, although the electron was first an object which satisfied Lorentz' postulates, it is now an entity which satisfies a different set of equations, those of Schrödinger. This is deductively formulated mathematical physics as against descriptive physics. To get the meaning of these postulates, it does no good to look into the immediacy. These are concepts by postulation. Dr. Margenau calls them constructs in the c-field, and I call them the theoretical component.

Thus we have two different kinds of knowing: One kind, concepts by intuition, gives us objects in the continuum of immediacy.

To the other, the Greeks gave the name, *Logos*. This designates a factor in you and me that is determinate in character.

This second kind of knowing, concepts by postulation, are not absolutely certain. You cannot see what you postulate, but verify it by formal logic. Concepts by postulation must be discovered by a genius like Einstein; this kind of knowledge comes out of the blue. Then concepts can be deduced and checked. This type of knowledge must be held with tentativeness. Some new fact or theory which necessitates a change in the postulates may turn up tomorrow. The Michelson-Morley experiment was just such a new fact.

Concepts by intuition can be shown but not said.

Concepts by postulation can be said but not shown.

The important question in any subject matter is, what are the key concepts? If you get these key concepts, you have the subject matter. But concepts by intuition and concepts by postulation must not be confused.

Dr. Margenau talks about the latest set of postulates about the atom in the West. Dr. Shapley talks about astronomy in which some of his concepts are concepts by intuition and others are concepts by postulation. Mr. Kunz's theory that there may be a mathematical formula common in the biological world is a concept by postulation.

Newton realized that one must not confuse sensed space, time, and motion with mathematical space, time, and motion. Everything we know is a synthesis of these two ways of knowing. Full knowledge is a synthesis of concepts by intuition and concepts by postulation. But what you do not see must be tied to what you do see. Dr. Margenau calls these ties correspondences. I call them epistemic correlations.

Western knowledge rests on the belief that conceptual knowledge is the important knowledge. The West has built society on a series of successive theories. However, the intuitional viewpoint on which the Orient has laid emphasis is just as essential to science as the conceptual. Both are real but convey different aspects of reality.

The second term of the course is as follows:

1. Feb. 5 — Formal and Operational Procedures in Science
   Henry Margenau
2. 19 — What is Scientific Truth?
   Ernest Nagel, *Professor of Philosophy, Columbia University*
3. 26 — The Nature of Man
   Gardner Murphy, *Professor of Psychology, College of the City of New York*
4. Mar. 4 — Theories of Learning
   Mark A. May, *Director, Institute of Human Relations, Yale University*
5. 11 — Signs, Personality and Society
   Charles Morris, *Lecturer in Philosophy, University of Chicago*
6. 18 — The Supraconscious in Human Personality and Culture
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SCIENCE AS A CULTURAL MOOD

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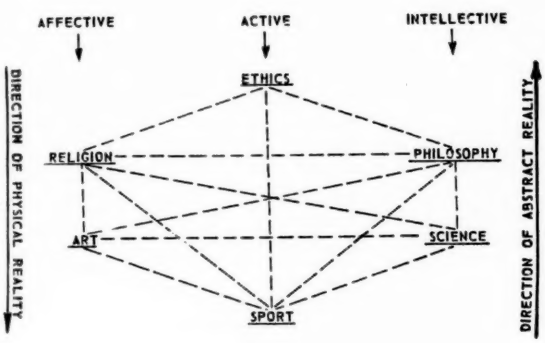
The Interplay of Civilizing Resources And Consequences of their Imbalance

This is the second in a series of occasional articles. The first, entitled "The Cultural Constitution of Man," appeared in Main Currents, *Vol. 8, No. 2, pages 39 to 43 (also available in reprints).*

As an aid in placing the present exposition in the whole argument, the schematic arrangement summarizing the content of the original survey of human cultural moods is here reprinted.



THE GOOD MAN IN A GOOD SOCIETY

I

A long-sustained general imbalance of the civilizing moods, though little recognized at the time, is often clear to suceeding ages as a cause and symptom of demoralization. Thus the youthful ebullience of temporarily successful 19th century mechanism led to some arrogance, and this in turn had strong effects upon religion. Overbearing from science was also evident in the contemporary art of that time, as conformity in realism, or escape through romanticism and sentimentality. Today the arts have not only at last gone through a rebellion against 19th century excesses, but are beginning to use actively the dimensional interests and resources of 20th century science. Adequate response by organized religious institutions to the recent dismissal of gross scientific materialism will no doubt eventually appear.

In periods when, conversely, religious dogmas have dominated the other moods, society has stated its spiritual feelings with confidence and clarity in its other formal cultural enterprises. Asoka's India displayed the ascendency of Buddhism in many educational works, just as mediaeval Europe experienced a cultural Christian solidarity and then social, aesthetic, and economic integration. To these times of more or less irrational, or socially enforced religious fervor, reaction also appears in well-known ways.

Occasionally and locally, sport also may triumph over all other moods—for good if the level is high, for ill if it is low—as it did so physically in the days of the huntsman in Georgian England. Foxes and game birds, red coats and homing horns, drink and gambling, constituted a ritual evoking a fanatical adherence which surpassed the claims of religion in a certain stratum of society. The art of the time ran to so-called sporting scenes, including aesthetically gruesome portraits of a brace of dead ducks hung upside down on a wall. These were as common locally for a few generations as *Pietas* had been all over Europe for centuries.

Since later times judge such epochs to have been defective, so also no doubt we shall be adjudged a failure because of the disproportion, and hence essential falsity in cultural activity which even now dispassionate critics are noticing as the true cause or index of our crisis.

Our current excesses are obviously in the direction of physical applications of science. The restoration of proportion waits therefore upon the interpretation of the method, and major contents, of science as a conceptual means to cultural ends.

II

Elastic adaptation among the moods is cultural and desirable, and probably essential not only to mental and moral well-being but to professional competence in the practical exercise of any one of them. Since science has not yet revealed everything, we have necessarily to call upon art and other moods in practical life. This eclecticism is quite evident in medicine, although the American Medical Association's public relations department, and that minatory white-coated figure in the advertisements of medical supplies and pharmaceutical products, would have us believe that medicine is a pure science. But if our entire reliance were placed upon *exact* scientific knowledge alone in diagnosis and medication, we would be limited in our successes to very few diseases, and in diet to few substances. The fact fortunately is that diagnosis and treatment are at present skills derived from exact, correlational and observational science, herbal lore, empirical experience, religion, philosophy, and aesthetic and economic sensitiveness.

The interplay of civilizing resources is seen even in surgery, which inherits from times and places which are often ignorantly considered hopelessly unscientific. Many of the chief gynecological instruments and processes in use today, and valuable medicaments, were employed and described centuries ago by Chāraka, Susruta and others. Caesarian section was part of Roman forensic medicine long before C. J. Caesar gave his great name to that commonplace operation.

The interne system provides some of the required experience of general medicine as an art. The English language declares that the doctor then practices on patient people. Eventually he may become so conversant with the incredible beauty, resource, and complexity of nature's organisms as to be a fairly effective physician.

The advantages of having adaptive cultural resources are therefore clear in the case of a practical art, or as a temporary expedient to pull a society together. But a continuing fatuous state of resignation to disproportionate cultural resources is another matter. In education such a state of affairs is intolerable. It may be impossible, for ages to come, to put an effective end to such recurrent disorders, because culturally we are scarcely half-evolved. Nevertheless educators have the conspicuous duty of being constantly alert to the actual state of affairs. Today the position is an active menace and especially gifted groups are aiming at achieving at least a better—though no doubt temporary and unstable—equilibrium so as to restore sanity, and to heighten the vitality of their own professional and soul purposes.

To take active corrective measures to restore balance in the curricular content we must determine how much (more properly, how little) valid experience and insight we possess and agree upon in each area. This part of the program will call for long range and systematic research for which an Institute for Integrative Studies should be set up.

Any reform must obviously begin with a common understanding of the *precise* function of each of the drives which subsume what we have been calling cultural moods. In respect to science, that much can be achieved at once, and the task is here assayed, after reviewing some well known considerations.

III

Science originates in the activity of the analytical mind, but its ultimate success is *due* to the constant exercise of abstract or classificatory thought. Without analysis the particular cannot be set off from the general. Without classification, there would be no general standard to suit the particular. This co-equal duality in the mind's functioning is the key to the nature of science, and its relation to the other disciplines.

Applied science is that aspect of the discipline which is concerned with the reduction of natural phenomena to sufficient order to allow of prediction and, in the case of small scale terrestrial affairs, some control and deliberate use of nature's materials and forces. The degree of success herein determines the level of the technological society which is thus made possible. Where the processes are beyond control, as in astronomical phenomena, only defensive adjustment and local advantages may be possible.

Prediction depends upon generalization. To believe the sun will rise, because it usually does, is good sense rested upon memory. To know where and when it will appear is good science, rested upon reason; and it is possible because certain generalizations about space and time are present. So much is alphabetical, and it indicates that science assumes (first) nature's dependability and (second) her enduring orders.

Nor does any scientist deny that these orders originate in Nature, and are obeyed and used by man. Some discussion has gone on among philosophers as to whether the objective world has an order in itself (or, indeed, whether the external world exists at all), or whether the sensory organism is not a screen which filters and systematizes random external impulses. For a scientist this should be an idle inquiry. He recognizes that standing waves of base note and overtones on a violin string appeal to the ear because the ear is suitably structured. He also knows that there is independent evidence that the tonal order (which might otherwise be supposed to be a selective invention of the ear) has objective reality because the (aided) eye—very different from the ear in structure—also reports on a simple ordered sequence, as the string vibrates first as a whole, then in equal halves, in thirds and so on. There is therefore order, and hence science is possible. It consists in the reduction of diversified, analyzable, phenomena to conceptually classifiable categories of ever larger embrace and simplifying orders.

The problem, "What is science, in itself, as a specific cultural experience, not as part of some practical art, and how is it related to the other cultural moods, without overlapping?" therefore appears to be part of a larger question, the nature of the experiencing and reflective process, in general in respect to all the cultural categories, and in particular in respect to science. It focuses in this form: "Does only the intellective process permit us to analyze and generalize, or do other moods function thus dually as well?"

IV

If only abstract thought—and no other form of abstraction—is possible, then science is indeed the sole hope of man, exact science supplants philosophy, and mathematics and logic are the only mental disciplines of any value to society. All other aspects of culture become useless inheritance, encumbering the scene. Some devotees of science are beguiled by these thoughts, and the resemblance of cortex circuits to the operation of electronic negative feed-back calculators encourages their hopes. The machines are not in-

sane. They are, in fact, structually completely reasonable. But they are models of what is called in pathology, doubting maniacs. In human beings suffering from this affliction, the will is inhibited. The machines are entirely without will, and are therefore quite unable to alter their course, once that is set up from without. Hence they are actually maniacs, in the proper and ultimate sense of the term. We do not admire that kind of behavior in man. Hence very few people go so far as to abandon philosophy as trivial or misleading recreation, assign ethics frankly to skilled animal trainers no longer masquerading as teachers, dismiss religion as mere ignorance, and denominate sport and art as harmless activities required (for some at present obscure reason) as exercise for an organism which later will be completely understood and maintained by coming scientific means. Yet all of these and other connected momentous questions turn, and have always turned, upon a single point, the nature of human abstractive or conceptualizing capacity in the experiencing process. If it be held that intellect alone functions to relate the particular to the general, such are the consequences. Hence this single item has to be considered by itself.

It has always been crucial, but contemporary physics has now exalted the importance of the conceptualizing function to a level much higher than in any known previous period of science. For abstraction today, in both macrophysics and microphysics, reaches into nonpicturable realms. Erwin Schrödinger remarks, in *Space-Time Structure* (Cambridge University Press, 1950, p. 1): "In Einstein's theory of gravitation matter and its dynamical interaction are based on the notion of an intrinsic geometric structure of the space-time continuum. The ideal aspiration, the ultimate aim, of the theory is not more and not less than this: A four-dimensional continuum endowed with a certain intrinsic geometric structure, a structure that is subject to certain intrinsic purely geometrical laws, is to be an adequate model or picture of the 'real world around us in space and time' with all that it contains, and including its total behavior, the display of all events going on in it."

The continuing success of this advance in science means that we are not only unable to see or otherwise sense some causal origins today, but that presently we shall be able *only* to calculate them. That is, the orders of nature inhere in a structure which is either superphysical and enveloping (in the case of the macrocosm), or subphysical and structurally basic (in the case of the microcosm), but in either case is natural, hyperdimensional, and rational. What we know of it will depend upon that supreme embodiment of reason, mathematics, combined with empirical evidence, frequently quite limited.

Is all that we are to know of the seat of order to be arrived at by the pallid abstractions of mathematics, because logical process alone is capable of valid generalization? On this question, I repeat, turns the whole cultural enterprise, and contemporary thinkers have been discussing it with renewed closeness of late. Much depends upon their success. I summarize the situation as I understand it, and shall offer a suggestion which seems to me most appropriate. Northrop's terminology is widely known, and I shall therefore use it for convenience, with apologies for over-compacting the argument which, as here noticed, cannot do justice to it.

V

Immediate apprehension of objective nature by the senses leads to concepts by intuition. These retain the color relations (this blue, and blueness) and warmth (this temperature, and hot-and-cold), but do not lead to a public (i.e., applied scientific) discourse, and a society cannot be erected upon them. The frustration begins in the variance of sense perception, the very act itself. This is dramatically seen in the case of a red-green color-blind person, who applies the word red to the experience grey, and whose private world hitches precariously upon the public traffic light. But the circumstance operates with normal sense perception, each person being unique in time and space.

For a public world, therefore, we are required to introduce the processes of the mind, limiting such introduction to functions as standard in minds as correct vision is standard for sensations of color. That is, if there were no identity of reasoning potential to be called upon in all minds, there could be no society of a high order. Modern exact science, most impressively, is structured of primitive assumptions agreed upon, treated by measurement and mathematics, plus formal logic. Up to this point everything important for abstraction is as Eddington left it, safe in the hands of a one-eyed color-blind man whose gaze is fixed upon pointers of clocks and other measuring devices. But no one was satisfied with this bloodless unfortunate. What are we to do to enrich his inner life? How do we retain the color and warmth of his sensory experience and keep it united with the rational structure?

Northrop proposes a matching process, epistemic correlation. In his attack upon the problem, he introduces the notion of an aesthetic continuum. That is, he conceives the continuum, already established by modern physics, to be directly apprehended locally (and, of course, fragmentarily) by perception. This is the intuitive concept of that which the mind can explore and reconstruct as concepts by postulations. Current scientific ideas about fields and space-time give cogency to the proposal, but the union of aesthetic experience of the continuum with the postulational structure by epistemic correlation leaves something to be desired, in terms of an uncompromising monism; and the postulated conceptual world is still coldly rational, in itself, though now connected up at every point with aesthetic warmth. We have therefore to focus attention upon a further step, fortunately provided by Indian philosophy.

VI

The fertile idea of the aesthetic continuum is anticipated in Hindu realism, the Nyaya-Vaishesika, the first of the three forms of insight recognized and systematized in the Vedic tradition. (Reference will be made to the two other couples, Sankhya-Yoga and Purva and Uttara Mimamsa, shortly.) The continuum bears the name Akāsha, a Sanskrit word fairly untranslatable except at considerable length. In brief, it is a basic harmonic-symmetric system which pervades the universe, such as can provide an underlying living and not only energetic order. It is the connective between space (Dik) and time (Kāla), and anticipates the space-time metric of modern Western science. This concept of the aesthetic field in its Indian form, where the reality of the continuum is also regarded as established, offers a solution for the Western philosophical predicament, because the abstractive part of the experiencing process is not narrowly or even primarily identified with logical reason.

The supra-logical conceptual process is not, however, advanced in Hindu realism (Nyaya-Vaishesika), which is only the first of the three insights (darsanas), and constitutes a preparatory discipline, corresponding to logic and science as we know them, but with the difference that knowledge does not end there. In Indian pedagogy it is put first so as to ensure that when the developing mind of the mature student comes to grips with the more profound aspects of the universe, he will be in a position to make the world intelligible to himself even though in itself it ranges beyond present human mental resources. In the Indian outlook on life, logic and science are the bony structure of a living reality, and such studies come first, but are only means to more meaningful ends. I must limit the exposition only to that which is pertinent to present purposes.

The function of the Nyaya (reason or logic) and the Vaishesika (particularly, i.e. particles or atoms) is to establish by reason the existence of a non-material natural order. The system thus anticipates contemporary science in this methodological sense. As in present-day physics, space (Dik) and time (Kāla) are conceived as having physical effects. The Akāsha is also not without a contemporary parallel. It is a non-material sonorous principle, reminiscent of modern resonance theory, the ordered dynamism which describes the chemical bond. The Nyaya-Vaishesika discipline refers the discovery of these and other basic principles to mind (manas), and recognizes its dual functioning as concrete mind (rupa manas), and abstract mind (arupa manas). Having established the reality of a non-material natural order, by intellective process alone, the Hindu realism gives place to the second form of discipline, the Sankhya-Yoga insight.

It is at this stage that a departure is made from European speculative systems. A deeper insight is to be achieved now not by self-disciplined reason alone, but with the aid of self-disciplined emotions. Again, as in the material realism, there is a method, Yoga, the yoking or linking of mind and emotion, and a resultant set of findings, now called not atomism (Vaishesika), but Sankhya, namely, enumeration, i.e. classification of the polar entities, consciousness or purusha and matter or prakriti, and what lies between these extremes. If the point be not taken that human frailty and inadequacy are rooted in shallow and ungoverned emotions which can be disciplined and united in functioning with the logical mind, then no hope can be entertained of appreciating the cogency of Indian philosophy. Modern depth psychology shows how astute is this estimate of the human situation. There is thus far agreement, as to one predicament, but the consequences of the admission that we suffer deep unconscious drives differ in East and West. The Hindu prescription was preventive, education of the emotions.

The Sankhya, then, affords that description of the supra-logical intelligible universe which results from understanding the world after personal emotions have been disciplined and fulfilled, and neither suppressed nor merely turned loose. It is succeeded in order by the final couple of disciplines, originally called the Purva and Uttara Mimansas, roughly, the earlier and later interpretations of scriptural inheritance. That is, Indian philosophy returns to correct and enrich traditional religion after exploring the universe by special disciplines. For present purposes the conclusions reached by the three darsanas can be summarized as follows.

VII

In the Indian outlook the cosmos is basically alive. Reality is ascribed to an all-embracing, superphysical, supreme Field, Brahman. This causal Field is non-material, what we would call a hyperdimensional domain, and hence embraces physical nature, and all else, including life. No philosophy is adequate which does not retain warmth and color, and the ethical force in aesthetic joy, and deep feeling. Indian philosophy, then, declares (with Whitehead and Plato) that the universe is alive; but it adds that its heart will be found only by a method of living, not a method of thought alone.

In this view, the generalizations of physics are reductions (with loss of color and warmth) at one extremity, and egocentric psychology is a reduction, with an exaggerated illusion of freedom, at the other. In this view, also, it is possible to establish a competent ethical science, rich in valid concepts, self-consistent, and true to nature, only when the life-process has a central position. So long as rationality (mathematics) is alone employed, the outcome will carry only an intellectual compulsion to ethical conduct, based on a logical knowledge of the sublime, natural, superphysical order.

Insight into this superior level of *living* natural order is not achieved by formal logic, and the

Nyaya-Vaishesika does not claim it does this. The task is assigned to the Sankhya-Yoga, and the Mimamsas. The role of science is to bring a final conviction that there *is* a sublime order. An appreciation of the living universal is possible, but only by the exercise of a special form of insight, which requires education as much as does the intellect. To this the Sanskrit term Buddhi is assigned, sometimes (but inadequately) translated as intuition.

There is a Greek equivalent, Θῦμός, but this also eludes translation. The term wanted should suggest the meaning found in the word faith, but the confidence implied is in known utterly orderly and just provisions and structures of nature. Ruskin, somewhere in *Modern Painters,* suggested the term Theoria, following Aristotle, but theory has now narrowed down to mean intellectual concepts. Intelligence is perhaps the best English word to associate with the Sanskrit and Greek originals, but the dynamism of the Sanskrit and Greek originals is lacking in the English term.

The implication of Indian monism is that concepts by intuition are possible because concrete (sensory) perceptions are accompanied by abstract feelings. That is, when we see blue we do not *think* blueness. The concept is first felt, and the mind tends instantly to get to work upon it. In the person in whom personal emotions are undisciplined and undeveloped, the impersonal, abstract, aesthetic feeling-tone tends to die away. Yet these abstract feelings are so deeply buried as to comprehend reason, and therefore if they are developed (as they can be) they add to mental process the peculiar living tone missed in thought. The world is then seen to be intelligible, that is, both reasonable and aesthetic, at one and the same time. Hence this form of insight impels to wiser living with a force not found in intellect alone. If the wiser living ensues, the conceptual nature grows because it now has something more nourishing than reason to feed upon.

VIII

The foregoing concept of human nature was commonplace in antiquity, and conspicuous among classical Greek thinkers. Hence the emphasis upon proportion, the golden mean, naturalism in art, revolt against excess embodied in the dictum, "Nothing too much." That there is truth here is evident in the differences between children in whom an inclination toward art is encouraged and those who concentrate upon science. But the exaggeration of such differences is unfortunate.

The Indian view implies that the bifurcation between the postulated and the aesthetic continuum, which Northrop so admirably proposes to repair, is artificial. The division does not arise from nature, but is an accident of upbringing, exaggerated in modern society by the climate and the calamities of our kind of education. Hence it can be circumvented. The corrective is not in more and better physical science, nor even more and better natural science, and more and better intellectual analysis and abstraction, by themselves alone. If the universe is alive, it is to be better understood only by new and better ways of feeling and of living. We may criticize in the Alexandrian Greeks the emphasis upon pure science and book learning, albeit our successes with Nature are in part consequences of the genius in Euclid, Apollonius of Perga, and others. Does not our ignorance of the organic nature of the universe imply that we in turn may be open to a like later judgment, because of our trying to *think* our way to a final insight which must be reached by laboratory exercises—that is, new emotional and physical ways of living—which alone can test the thoughts? Does not the modern West submit ignorantly to a schizophrenic existence, between the extremes of respect for egotistic individualism and belief in the use of insentient energies as sovereign remedies for society?

Innumerable evils thus appear to arise from one basic educational error: the assumption that only intellective process is capable of conceptualizing. From this stems the bifurcation which, once begun in childhood and youth, cannot be readily repaired in later years.

One consequence of the bifurcation is that men come to make a false distinction between fine and useful arts. They consider science superior to philosophy. Ideals are divorced from practices, and in the end we say one thing (kindness and considerateness) and do another (practice autocide). It is a singular fact that peoples who speak of love, and exalt the doctrine, "Thou shalt not kill," find themselves engaged in slaughter in peace, on a scale which they have not as yet surpassed in war, up to the present, although currently it is true they are preparing to improve their military performance so that they may yet make a shambles of the planet.

We moderns have rested our hopes upon a technological society which depends in turn upon mathematics. No doubt that discipline is important. Yet it is almost too penetrating. As we now use it, chiefly for expertness in physical science, it bypasses the living intelligible world, cutting through to the skeleton of the organic universe.

IX

In sum, then, science as a cultural mood rests upon the correct balance of concrete and abstract rational process. However, this is not the only form which abstraction takes. Concrete (personal) and abstract (altruistic) emotions can also be evolved by a good education.

Nor does the sequence end there. The earlier and later Indian Mimamsas (exegesis or scriptures) go on to say that sport is in a certain sense the greatest of all the concrete cultural activities, because the abstract correlate in this case is the sublime order of nature in which ethics inheres cosmologically. That sublime order is, in fact, called the Lila in the Sanskrit. This, for once, is a word

with a closely approximate English equivalent, sport, then in the sense of fun or joy, in the sense of biological new departure with archetypal rules, in the sense of fairplay and justice. This sublime order is the law (Dharma) of which love is said to be the fulfillment. The Indian concept of Buddhi therefore is like the Greek θυμός, an enthusiasm, a daimonism. Its meaning goes far beyond that of the Latin intuition, and the reclamation of these cultural riches gives promise of helping us to restore the break which Roman philosophical poverty and the Dark Ages imposed on the West, and hence, to resume continuity in culture, ancient and modern. They would be helpful, if pursued in our outlook, in bringing understanding between East and West.

Our Western approach to the task must necessarily be accompanied, if not preceded, by elucidation of our scientific concepts. For these concepts offer us so much for a better conceptual insight, even while their ungoverned technological consequences threaten us with turbulent times and intense physical suffering. But we would do well to remember that this is but a beginning. The end must be a re-balancing of all the cultural moods, of which science is but one.

THE SPECIALIST AS A PSYCHOLOGICAL PROBLEM*

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By way of introducing the specialist as a psychological problem, I should like to refer to an accident that occurred several years ago in a system of caves in one of our southern states. A professional geologist, who had set out to explore the formation of rocks and their enclosures, was found dead near the entrance to which he had been unable to make his way back. Traces of his footsteps told of endless, circular, and repetitive wanderings in the subterranean maze. The circle this particular specialist described proved fatal to himself, which was strange in view of the fact that he had been a cave explorer for years. He had concentrated on the composition, the texture, and the stratification of rocks as keys to their genesis; he had paid little attention, it appeared, to their topology, even though this very topology of caves is known to depend intrinsically on the geological structure of the formations that shape them.

Intrinsic relationships are not concatenations of independent factors but features of wholes. The geologist who did not understand the topological structure of the maze that caught him, did he understand the subject matter of his specialization? His understanding, in any case, was not sufficient to make him master of the situation. It did not embrace the whole to which he should have applied himself.

How does this case apply to the specialist in general? Situations of the kind described above are rare, because the same trend of social history as that which produced the assembly line as well as the specialist, has also produced conditions of human coexistence which not only permit but even foster such segregations between a person's existence and his professional functions. It is only when the safeguards of mechanized civilization are suspended that the defect becomes visible, and that is what makes the incident so instructive. The most important point it brings into focus is a peculiar lack of mastery over both the self and the object, a defect which there is reason to believe tends to be strictly correlative. But this defect becomes a problem to the person himself only in the case of those in whom a specialistic attitude, induced by society, is defied by an unconquerable demand for wholesomeness.

A number of clinical cases in my own experience were extremely brilliant specialists, characterized by both a particularly great capacity for work-and-thought concentration, and at the same time a resistance to their field of specialization, which took the form of an indomitable urge to understand, master, and make wholes. It was this urge which led them originally to their orbits of interest, where they were only to find that they were not allowed by their vocation to proceed according to their subjects' own given dimensions, contours, and intrinsic nature, but were supposed to tackle these subjects according to an arbitrarily preimposed determination of aims of knowledge. Without their resistance to this situation, these specialists would not have become clinical cases; what led to the conflict was not a more pathological, but a healthier trend than the one that ruled the social environment, for the urge to deal

*This is a condensation of an article which appeared in *Social Research* of March, 1951.

in wholes, understandingly or creatively or both, is a perennial characteristic of human nature.

Since the beginnings of the industrial revolution this urge, which used to have free play, has, through the division of research and of labor, been increasingly frustrated. It would seem that this unique change in man's psychological, as well as social, situation should constitute a major topic for a science of man; but the same irreversible trend which has produced the topic has also, apparently, provided safeguards against the danger of inquiry, for there is at present no science of man. The trend operates not only against the unity of human existence; it also operates against that unity of man's knowledge about himself which would give him a conceptual scheme for an overall context of his life. Without such a conceptual scheme into which can be fitted the partial aspects of human existence, it is impossible to recognize in their true nature changes in man's situation which lie in more than one such area and which pervade all scientific aspects of human existence at once. Such a conceptual scheme is, in turn, not conceivable without a primary orientation on the scientist's part to needs and values *perennially human.* The perennially human, while requiring the now neglected study of history to be seen and understood, is itself not the historical, not the past, but on the contrary all that which resists historical and social changes and persists timelessly throughout them. It is evident that this element of the perennially human easily and dangerously drops out of sight in a time of accelerated social change such as ours, and that reorientation to it is all the more necessary if contemporary man is to be enabled to master the stream of changing conditions around him rather than drift with its current.

The clinical cases mentioned above point to the inseparability between the psychological situation of the specialist and the peculiar present trends of the civilization in which he is caught. The great question is what can the segregated function possibly accomplish if the support of the personality is wanting. According to widespread belief, it should be able to accomplish more and more, better and better. But what are the criteria here for the "more" and the "better"? They are themselves technical; they are set by the particular use to which the specialist's skill is put. Unlike the criteria of the person who pursues an interest for its own sake, these criteria do not derive from the intrinsic nature of the object; thus the truth about the object is no longer central to the operations with respect to their goals. On the part of the person, the specialist himself, we find a correlative lack of participation of the motivational mainsprings.

The thesis that specialization is not a way to the mastery of the subject matters of science was expressed in its most radical form by Bergson. The specialty, he said, which renders the scientist *maussade* — boring, sour — renders the science sterile. This sounds too sweeping; yet if we look at the distribution throughout the sciences of those triumphs of which we can actually be sure, we find clusters of them, progressively more dense, in the direction of those fields with subject matters further away from human existence — mainly in physics. Closest to human existence, in those fields of psychology which explicitly deal with it, we find the least amount of certitude, though not necessarily of its assertion. This is as odd as it is perturbing, because the distribution of *responsibilities,* which in our present society lie on the shoulders of science, shows they wax in density away from physics and in the direction of psychology. They do so because its subject matter, man, has lost in self-certitude at the rate at which he has found certitude in physics; believing he has gained in power over the forces of nature, he is seeking the lost self-certitude in the self-assured vagaries which popular psychology offers.

It is in these vagaries of popular psychology that specialism comes into sharpest focus as a social phenomenon. The attitude of the psychologizing specialist can be characterized by a striking lack of humility before his own subject matter, a blindness to its given dimensions, and a mechanistic inclination to force it to yield data which are the product of the method of investigation rather than intrinsic to that which is investigated. Compare the situation of the psychologizing specialist with that of the specialist in physics. The subject matter of physics, being remote from human experience, admits of comparatively easy separation between phenomenal observations and theoretical laws behind the phenomena, without the danger of a constant mix-up between the two. The subject matter of physics could be defined in terms of problems which led the physicist on; in some fields closer to human existence, even the definition of problems, the aims of knowledge, may vary. Correlative to this fortunate situation on the *object* side of physics, we seem to find, not any less interest in his own science on the part of the physicist, but a greater basic detachment from aprioristic premises and from the danger of confounding his own school of thought with the science. As we move nearer to fields which do concern human existence, the typical specialist's attitude in defense of his theoretical position can be seen to grow increasingly more emotional and more inclined to disparage rather than answer his opponent's points.

Specialistic attitudes, then, do not lead to an organic unification of the field of a science unless the nature of its subject matter explicitly calls for such attitudes. The often-heard claim, however, that they are necessary for a successful penetration of all the subject matters of science, in brief, for *concentration* per se, not only is at odds with the given nature of certain subject matters but at least as much with that of concentration

itself. The lives of many of the most successful scholars in all sciences are full of amazingly successful concentrations on subjects completely remote from their main fields of interest. This raises the whole problem of successful concentration as a psychological one and suggests that concentration is a cyclic phenomenon which, like any other, cannot be understood without its own opposite. The less concentrated, the more relaxed, and the wider in scope a person's orbit of phenomenal experience in the intervals *between* the phases of concentration, the stronger and more penetrating concentration is likely to be.

It would seem, then, that the richer the phenomenal experience, the richer the *observation* in a state of receptive detachment, the sharper and purer the theories that draw from it. The attitude that favors a full articulation of such cycles does not, as a mechanistic misunderstanding has it, favor any such thing as spreading over field after field. It is not concerned with everything, but with the whole. A whole, whether encountered by the physicist or the social scientist, is a lawful context which gives significance to each particular part-phenomenon that articulates itself within it; what makes its inner lawfulness understandable, however, is its own overall significance. The true academician's subject matter, in principle, thus becomes the universe; whatever he encounters—and it may lie in exceedingly small sectors of fields—occurs to him in such a way as to represent a universal order. Such a universal order, since it already determines the phenomenal structure under the scientist's observation, is inseparable from that structure; to the extent, then, to which it drops out of his sight, phenomenal structure will escape, first his eye, ultimately his theories.

This allows for a closer differentiation between legitimate and illegitimate "specialism," and for a definition of "specialistic attitude." It is evident that no wrong attaches to any specialization, and concentration on a particular subject matter which, in setting its method of analytic attack, closely follows the given structure of the object. If the object happens to be a whole, such as the whole subject of entomology, or any of its self-articulated subdivisions, the wholeness of that object implies at once the *universality* of good order constituent to nature throughout, and a distinct *separateness* from other subject matters of nature; a separateness which, in favoring the concentration of the scientist's focus upon it, legitimatizes, at the same time, its specialistic restriction. It is different for such subject matters of one science as are inseparable from other subject matters lying within a different science and in actuality forming one with them. Specialistic narrowing of focus here cannot but fail to perceive the order of the whole and cannot help to replace what it misses by a mechanical order which it imposes on the subject by means of procedure.

Specialistic attitudes in the present sense, then, are characterized by a scientist's preoccupation with his own method, his unsuspecting readiness to accept as object properties what may be the result of his inquiry itself, and, as an inevitable corollary, a growing loss of the capacity for phenomenal observation—for observation as *primary* experience—on his part. This dominance of the technical over the intrinsic becomes the more a danger the closer the subject matter happens to lie to the scientist's own sphere of existence. Within the realm of the social sciences, "specialism" in this sense not only is helped by their existing and in many ways arbitrary subdivisions but by the scientist's natural lack of focal distance from his subject (man), which prevents him from perceiving its total order.

That specialization has already reached its climax as a process phenomenon of social history is, unfortunately, improbable. It is at present assisted by the fact that the enormous growth of specialistic groups as professional groups may delude the specialists as well as society into assuming a corresponding magnitude of the simultaneous accumulation of certitude on their part. Moreover, it is assisted by the unwarranted specialistic inclination of all scientists to regard the adjoining science as beyond understanding. As this segregation tendency spreads in all directions, the universality of science is lost in more than one respect, with provincialism as the only possible outcome. When truth is sacrificed to operationalism by the technician, universality to arbitrary subdivisions of whole subjects, the training ground of the seekers of either ideal is no longer firm: for the first time in history, academic freedom, in nontotalitarian countries, is threatened not exclusively by the traditional dangers from without, but by a conspicuous weakening of its own impulses, which takes the form of a slow and inarticulate renunciation of the only two ideals on which it can be founded.

The specialist has been presented as a psychological problem; and yet we readily see that he is a problem to more than psychology only and that he will not be understood from the viewpoint of a single science unless he is simultaneously understood from all others that apply. That he can be presented as a psychological problem does not mean that the answer to it must be psychotherapeutic; the solution must clearly be a pedagogic one in this case; the key to it is in the hands of teachers. A science of man, as true to philosophy as to large bodies of as yet uncomprehended facts, which it may be hoped will emerge from the vicissitudes of a specialistic age, will have to be true, first of all, to the teachings of these very vicissitudes. The obstacle to its growth is at present the technician. The alternative which his existence poses does not admit of a patchwork of compromises. Sooner or later, but inescapably, it must force a decision.

SOMETHING OUT OF NOTHING

Current Use of the Symbol Zero And its Future as an Exponent

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The editor of MAIN CURRENTS wishes to express his gratitude to the author, who has been so good as to prepare this article at our special request. The object, in the editorial view, has been to indicate how intimately the development of fundamentals and higher reaches in mathematics by the ancient Hindus was connected with both philosophy and metaphysics, on the one hand, and scientific theory and application, on the other. This is not the occasion to discuss this significant fact. The author shows cogently and interestingly how the Hindu invention (or discovery) of one single primitive idea links quality and quantity.

Zero was used in metrics by Pingala before 200 B.C. in his Chandahsutra. In calculation it occurs in the Bakhshali Manuscript, about 200 A.D. As early as the 6th century, the sign used is specifically described as a dot. It is generally and safely assumed that this was the original form. Later the circle supplanted the dot. The Moslems learned both forms, and (as we are here reminded) brought the idea, and the circle sign for it, to Europe. Much later these concepts stirred George Boole, entirely afresh, through the influence of the Everest family. See **History of Hindu Mathematics,** B. Datta, and A. N. Singh, two vols., Motalal Banarsi Das, Lahore, 1935. The third volume in this series will deal with the Hindu invention of calculus. F.L.K.

I. *The Development of Zero*

When man invented the *symbol O* he literally made something out of nothing. With this invention it became possible to deal comprehensively and exactly with quantities. Our decimal system is dependent upon the zero, just as our arithmetic would be crippled, and our engineering would be clumsy and primitive without it. In fact, it may be argued that our civilization might not have developed its present technological power without the precision the zero symbol contributed.

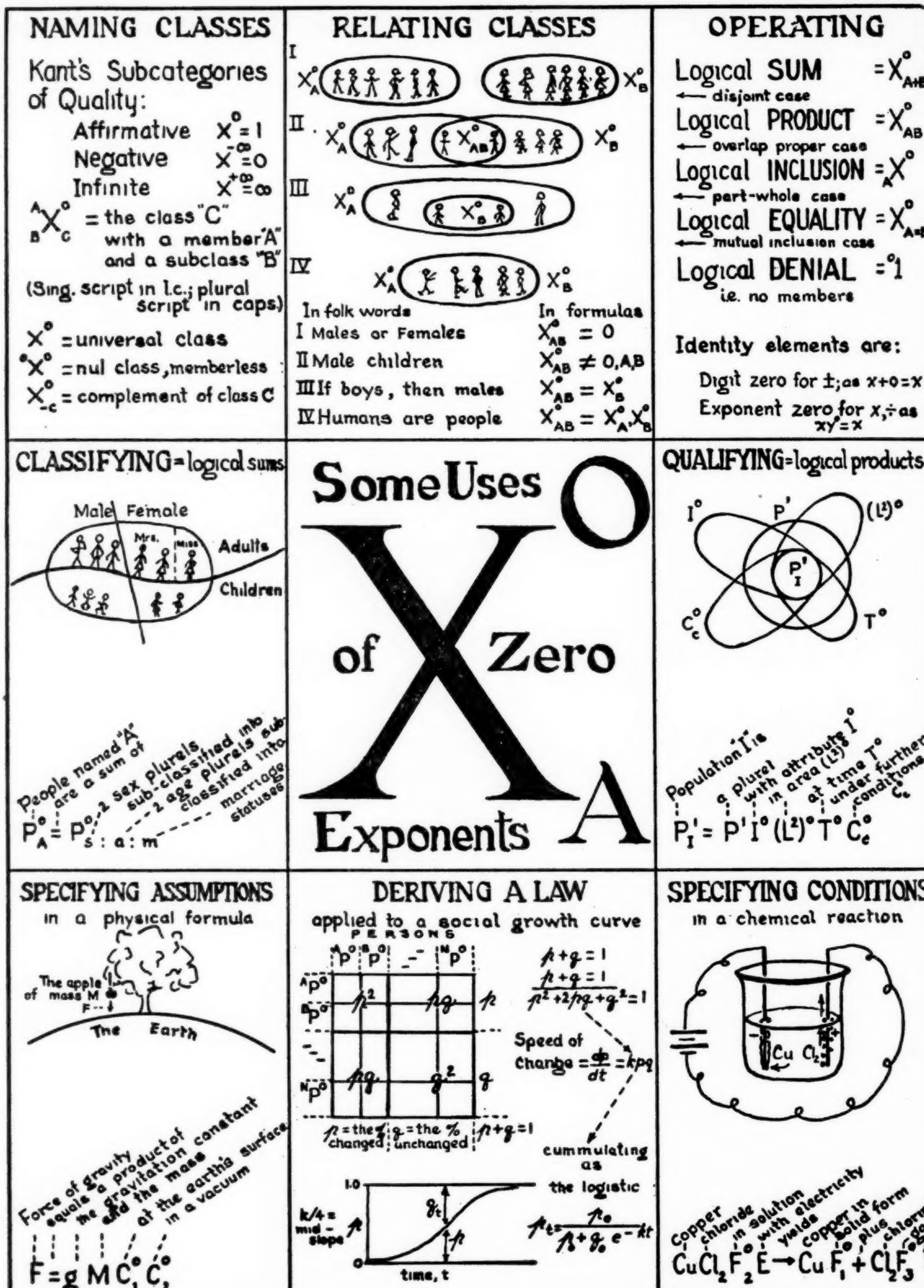
A *written* symbol for zero first appeared during the ninth century in India. It was also invented independently in the Mayan calendar. From India via the Arabs it came to Europe along with our Hindu-Arabic numerals and decimal system. It inspired mystery and resistance in the course of winning acceptance. People asked: "Why name something that isn't there? A name means something, what is the something that zero names? It names nothing!" The mystery it inspired left its trace in English where the word for a secret code written in cipher comes from the Arabic "sifr" meaning zero. The resistance the innovation provoked is illustrated by an ordinance in medieval Marseilles forbidding the use of the cipher (zero) and requiring all merchants to compute "in plain and clear Roman letters." Imagine quickly computing today with plain clear letters the cost of CLXXXVIII eggs if they cost XXXVIII cents per XII!

The Hindu, Arabic, and Mayan symbol for zero was a dot — not our present elliptical o. A point seemed the nearest to writing nothing or denying something one can get. The Hindus called it "anu" meaning "what goes with—." Taken with any number it gave an origin point (as for a coordinate) and made the number appear as a difference between two points.

Zero became still more useful when combined with grouping digits to develop *place* symbols. When groups of ten were used, thanks to man's ten fingers, our decimal system resulted. Thus the place or position of a digit developed a meaning in addition to its shape. In this way 2304 expresses two thousand plus three hundred plus four: $2 \times 1000 + 3 \times 100 + 0 \times 10 + 4 \times 1 = 2304$. This is shorthand for the operation "multiply 1000 by 2, multiply 100 by 3, multiply 10 by 0, multiply 1 by 4 and add the four products."

In a similar way the exponent developed as a position symbol. Its position in the upper right corner as a post-superscript (1^x) to any base letter, X, as in X^x, carries a meaning over and above the meaning carried by the shape of the script, x. The exponent's meaning is "multiply the base by itself." It denotes how many times its base is to be taken as a factor. Thus X^2 means X squared or X multiplied by itself. This leads to the rule: "To multiply, add exponents; to divide, subtract exponents." Thus X^3 divided by X^2 gives $X^{3-2} = X^1$. The reciprocal of any number is that number with an exponent of minus one: $X^{-1} = 1/X$.

Much like any other number, zero came to mean an amount. It means zero amount and is handled like any other amount in arithmetic (except for using it as a multiplier or divisor). But it also is an implicit operator when in a several place number, since it commands "don't do anything," "don't count any ones, or tens, or hundreds, etc., here."



NAMING CLASSES
Kant's Subcategories of Quality:
Affirmative $X^0 = 1$
Negative $X^{-\infty} = 0$
Infinite $X^{+\infty} = \infty$
$^A_B X^0_C$ = the class "C" with a member "A" and a subclass "B"
(Sing. script in l.c.; plural script in caps)
X^0 = universal class
$^0X^0$ = nul class, memberless
X^0_{-c} = complement of class C
RELATING CLASSES
I X^0_A X^0_B
II X^0_A X^0_{AB} X^0_B
III X^0_A X^0_B
IV X^0_A X^0_B
In folk words
In formulas
I Males or Females $X^0_{AB} = 0$
II Male children $X^0_{AB} \neq 0, A, B$
III If boys, then males $X^0_{AB} = X^0_B$
IV Humans are people $X^0_{AB} = X^0_A, X^0_B$
OPERATING
Logical SUM $= X^0_{A+B}$
disjoint case
Logical PRODUCT $= X^0_{AB}$
overlap proper case
Logical INCLUSION $= {}_A X^0$
part-whole case
Logical EQUALITY $= X^0_{A=B}$
mutual inclusion case
Logical DENIAL $= {}^0 1$
i.e. no members
Identity elements are:
Digit zero for ±; as $x+0=x$
Exponent zero for ×, ÷ as $xy^0=x$
CLASSIFYING = logical sums
Male
Female
Mrs.
Miss
Adults
Children
People named "A" are a sum of
2 sex plurels sub-classified into
2 age plurels sub-classified into
marriage statuses
$P^0_A = P^0_s : a : m$
Some Uses of Zero Exponents
X^0_A
QUALIFYING = logical products
I^0
P'
$(L^2)^0$
P'_I
C^0_c
T^0
Population I' is
a plurel
with attribute I^0
in area $(L^2)^0$
at time T^0
under further conditions C_c
$P'_I = P' I^0 (L^2)^0 T^0 C^0_c$
SPECIFYING ASSUMPTIONS
in a physical formula
The apple of mass M
F
The Earth
Force of gravity
equals a product of
gravitation constant
the mass
and the mass
at the earth's surface
in a vacuum
$F = g M C^0_1 C^0_2$
DERIVING A LAW
applied to a social growth curve
PERSONS
$^AP^0$ $^BP^0$ $^NP^0$
p^2 pq p
pq q^2 q
p = the % changed
q = the % unchanged
$p+q=1$
$p+q=1$
$p+q=1$
$p^2+2pq+q^2=1$
Speed of Change $= \frac{dp}{dt} = kpq$
cummulating as the logistic
$p_t = \frac{p_0}{p_0 + q_0 e^{-kt}}$
1.0
k/4 = mid-slope
q_t
p
0
time, t
SPECIFYING CONDITIONS
in a chemical reaction
Cu
Cl_2
copper chloride
in solution
with electricity
yields
copper in solid form
plus chlorine gas
$CuCl_2 F^0_2 E \rightarrow Cu F^0_1 + Cl_2 F^0_3$

When logarithms were invented, zero acquired further usefulness. Logarithms are exponents. A zero log means a zero exponent. The log of unity is zero. Thus log tables start with unity or X^0 as their origin point.

A more recent mathematical invention — the development of the theory of groups — views zero as an *identity element*. An identity element is any element of a group which leaves other elements unchanged when it operates on them. Thus if the operation is addition, adding zero to any quantity leaves it unchanged. Zero is the identity element for subtraction also, since $X - 0 = X$. Having defined the notion of an identity element, it is disturbing to find this element apparently changing its own identity for different operations. That is to say, whereas it is zero in the case of addition it turns out to be unity in the case of multiplication ($X.1 = X$ and $X/1 = X$). But this difference, inherent in mathematical procedures, is resolved by the zero exponent. When multiplication is regarded as addition of exponents, then the identity element is still zero — in the exponent position ($X.X^0 = X$, $X/X^0 = X$).

The invention of the symbol for something that isn't there has had a profound effect on man's ability to think accurately. But, hitherto, the symbol for nothing, the digit zero, has largely been limited to the realm of *quantities*. As the realm of *qualities* looms far larger in human affairs, we now propose to examine the possibilities for more exact and rigorous treatment of the qualitative realm by wider use of the zero as an *exponent*.

II. *General Notion of the Zero Exponent*

The use of the zero exponent in the qualitative realm may be stated in a few challenging generalizations. The zero exponent can help to state more explicitly and rigorously:

1. The *assumptions* underlying any proposition or program.
2. The *conditions* necessary for any law or procedure to be valid.
3. The *definitions* of any terms or situations.
4. The *relations* of things in patterns, organizations, or systems.
5. The *operations* needed to identify or produce any product.
6. The *classification* of phenomena in any field (as an algebraic sum).
7. The *qualification* of anything in any way (as an algebraic product).
8. The *identity element* for mathematical multiplication.
9. The *harmonizing* of quantitative with qualitative algebra.
10. *Words, sentences,* or *ideas* generally.
11. Any *quality* as a Kantian "category of the understanding."

These uses will be illustrated in the next section, first in the different semantic disciplines and next in the various sciences, the approach suggested by the accompanying diagram.

The zero as an exponent is written in the upper right-hand corner of any base symbol, such as X^0. This may be defined to denote *one class* or kind of thing. Thus X^0_A might denote "Americans," X^0_B might denote anything "British," X^0_C might denote any "commodity," X^0_D might denote 'diseases," X^0_E might denote "anything existing," etc., etc. The subscript simply names the particular class of entities which X^0 denotes. In this way the symbol X^0 (read as "X-to-the-zero-power" or simply "X zero") denotes any class or kind of entity whatever. With identifying subscripts it can denote any class of thing, any people, any place, any time, any idea. It can be substituted for almost any word in our largest dictionary, for example. When limited to classes as in Symbolic Logic, X^0 can denote the universal class which includes all classes within one "universe of discourse." X^0 becomes a unifying symbol for anything the human mind can symbolize whether material object, event, situation, abstract concept, or symbol of these or anything else. It can symbolize other symbols in any combination or compounding. As long as people can distinguish its referent that referent can be symbolized by X^0 with a subscript naming the referent. In short X^0_A can denote "anything" or more exactly "any one kind of thing" — provided that people can qualitatively distinguish its referent. Its operational definition then is that people can and do distinguish what it means. The more people who can so distinguish its meaning, when formally tested in a particular case, the more reliable is the operational definition in that case. The zero exponent thus embraces the entire qualitative realm — whereas the zero digit in a base occurs only in the much smaller quantitative realm.

But just how does X^0 come to mean any qualitative entity? What justifies using the zero-in-the-exponent-position to mean this instead of any other arbitrary symbol such as U (for "a universal symbol")? The answer is that choosing the zero exponent symbol carries the meaning of the zero concept over from the quantitative realm to the vastly larger qualitative realm of human thinking. The zero exponent tends to unify the qualitative and the quantitative in providing a bit of symbolism which permits both realms to be handled with a more exact and single set of rules as in algebra. Thus X^0 in ordinary algebra is equal to 1[1]. But one of what? It is one of anything, a pure number when without a subscript. With a subscript, however, X^0_A means unity of the kind denoted by the subscript A. The unit may be an

[1]Any quantity with a zero exponent equals unity. This may be shown by remembering the operational rule in algebra that in dividing two similar quantities their exponents are subtracted or in multiplying them their exponents are added. Thus $X^1/X^1 = X^{1-1} = X^0$, since anything divided by itself is unity. X to the zero power means unity always in ordinary algebra. $X^1/X^1 = 1 = X^0$.

inch or a centimeter, an hour or a day, a dollar or a man, a war or a situation, an instance or a class of anything whatever. Every concept — from "God" to "nothing" — can be a case of X^0, a denominate unit. Then with anything recast in the form of X^0_A this can be operated upon with the rules of algebra. X^0_A can be added or subtracted, or multiplied, equated or otherwise related to other X's both qualitative (X^0) and quantitative ($X^{\pm 0}$). This tends to integrate the quantitative realm (which is the field of mathematics) and the qualitative realm (which in rigorous form is the field of logic and in unrigorous form includes all language and ordinary thinking of people).

III. *The Zero Exponent in the Semantic Disciplines*

Philosophers from Aristotle on have sought the basic categories of human understanding. Kant reduced them to three categories — quality, quantity and relation.[2] These categories are specifiable by the exponents of zero, one, and two (or more), respectively. Thus X^0 can denote any quality, any thing distinguishable in kind; X^1 can denote any quantity, anything of any one kind which is distinguishable in degree; and X^{2+} can denote any quantitative relation among two (or more) qualities or quantities. The zero exponent thus helps to classify all knowledge at its top or most abstract level. It can comfort the minds of systematizers of monistic bent, by helping to resolve some of the dualism of Kant.

In the field of *logic,* X^0 when coupled with appropriate subscripts[3] can denote any class, relation, sentence, or operator. These are the chief entities making up Symbolic Logic.[4] Consider, for example, the logical sum and the logical product of classes as these are much used operations. Every sentence we utter is loosely built up of such sums and products without most of us knowing it. The logical sum of classes A or B is the class whose members are members of class A *or* of class B. Thus people are men *or* women. "Or" is the folk word for "plus" here. People = men + women. Thus every class is the logical sum of its subclasses or parts. Every subclassifying in successive levels into a hierarchy or classification scheme therefore represents a series of logical sums. When we subclassify people (P^0) by sex (= s) and then by age (= a) and then by marital status (= m) (as suggested on the accompanying diagram) we have three logical sums. This classification in three levels can be written as an algebraic formula as $P^0_{s:a:m}$ With such formulas the rules of symbolic logic and matrix algebra tell how more exact and complex calculations can be made than are possible with words or tabulations even.

The logical product of class A and class B is the class AB $- X^0_A \cdot X^0_B = X^0_{AB}$. Thus a telephone poll of voters yields a logical product composed of a plurel or class of people (P) who are simultaneously members of the class, voters, I^0; *and* members of the class of residents in the polled area, L^2; *and* members of the class polled on date T^0; *and* members of the conditioning class "polled by telephone" C^0. This gives the explicit formula for the logical product as $P^1_I = P^1\ I^0\ (L^2)^0\ T^0\ C^0$

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[2]His fourth category — modality — seems reducible to subcategories of the three above. For fuller exposition of all this see the author's *Dimensions of Society,* Macmillan, 1942, 917 pp.

[3]Our S-notation of which the zero exponent is one part attempts to unify and standardize the variant notations of the calculus of classes, of relations, and of sentences in logic, with the notations of mathematics and statistics, matrix algebra and semantics, and the chief notations of the empirical sciences. It is developed in full in the author's publications, chiefly:

Dimensions of Society, Macmillan, 1942, 944 pp.

Systematic Social Science, University Book Store, Seattle, 1947, 788 pp.

"A System of Operationally Defined Concepts for Sociology," *American Sociological Review,* Vol. IX, No. 5, ct. 1939.

"A Systematics for Sociometry and for All Science," *Sociometry,* Vol. II, No. 1, 2, Feb.-May 1948.

The brief remarks on the zero exponent in this paper are more fully developed and supported in the publications above.

[4]In the calculus of classes, for example, let X^0_C denote any class C (such as "people"). Let the pre-superscript ${}^{A}X^0_C$ denote any one number of that class (e.g., a person) and let the pre-subscript ${}_{B}X^0_C$ denote any one subclass (e.g., women as a subclass of people). Let these three scripts (${}^{A}_{B}X^0_C$) other than the exponent be called "descripts" as they describe respectively an element, a part, and a whole or the "one," "some," "all" of classic logic. Let a capital descript denote the singular, naming a particular member, subclass or class; and let a small letter descript denote the plural, naming a set of members, subclasses, or classes. In this scriptal notation the chief classes and relations of classes in logic become:

the universal class	$= X^0$	i.e., the class of all classes
the nul class	$= {}^{0}X^0$	i.e., the class with no members
the complement of class C	$= X^0_{-C}$	i.e., the universal class without class C, e.g., all classes except C
the logical product of classes A plus B	$= X^0_{AB}$	i.e., the class that is simultaneously A *and* B, e.g., boys are males *and* children
The logical sum of classes A and B	$= {}_{A+B}X^0$	i.e., the class that is A *or* B, e.g., people are men *or* women
The inclusion of class A in class B	$= {}_{A}B^0$	i.e., the class that is entirely a part of another class, e.g., boys are a subclass of males
also	$= (X^0_{AB} = X^0_A)$	i.e., the product is the included class
The equality of classes A and B	$= X^0_{A=B}$	i.e., two classes which include each other, e.g., people are humans and humans are people
also	$= {}_{A}B^0\ {}_{B}A^0$	i.e., A includes B and B includes A

When this standardized set of scripts is combined with the zero exponent, one can specify and deal with the calculus of classes, for example, comprehensively and parsimoniously. The standard operations on classes and the varieties of classes can be comprehensively written in terms of these four scripts at the four corners of a base letter. They can also be parsimoniously written as was shown by a forty per cent reduction in number of symbols when the laws of the calculus of sentences were translated from the usual notation of symbolic logic to this S-notation.

(see accompanying diagram). The factors in a logical product thus *qualify* each other. This qualifying is a major part of all thinking; for almost every sentence is such a loose product of its words as factors. Each word qualifies the whole sentence much as an adjective qualifies a noun. With the aid of zero exponents and the other scripts, this qualifying can be done explicitly and rigorously by the rules of algebra.

This algebra for entities, which we propose to symbolize with zero exponents, was largely invented by George Boole. It develops a consistent set of rules for dealing with qualitative algebra. But Boolean algebra *seemed* to conflict with ordinary algebra in that when a quantity is raised to the nth power in ordinary algebra we in effect add together n exponents of unity, whereas in Boolean algebra (where the logical product of a class times itself *is* that class) we in effect seemed to be denying this rule of adding exponents. But the zero exponent gets rid of this apparent inconsistency because we can state the logical product of a class by itself as $X^0 \cdot X^0 \cdot X^0 \ldots \cdot X^0 = X^{0+0+0 \cdots +0} = X^0$ so that the logical product is a special case of mathematical products in general.

This illustrates one use of the zero exponent in mathematics — to integrate its rules and results more closely with symbolic logic — to unify handling of qualities and quantities in the same equations.

In statistics one use of zero exponents is in binary elements.[5] A binary number has just two values such as 0 or 1. A binary element is an all-or-none random variable having only the values of 1 or 0. This has many uses. The electronic computers, instead of using our decimal system, build up all numbers out of binary numbers. They handle binary numbers by a vacuum tube going on or off for a "1" or a "0" — which it can do well over a million times a second. Such binary elements, typified in tossing pennies, yield the binomial distributions and the normal distribution when n, the number of binary elements, gets large. These compound in turn into the Gramm Charlier series to form perhaps most of the frequency distributions that commonly occur. Again, all statistical probability theory is based on the mean, p, of a binary element, which is called a probability and is the proportion of times a binary element had one of the two values 0 or 1. But what have binary numbers to do with zero exponents? The answer is that zero as digit and as exponent specify these two values of a binary neatly. For as digit, zero is the 0 value of a binary, and as exponent zero gives the unit value since $X^0 = 1$. Hence ${}^{1,0}X = X^0, 0$. The two positional meanings of zero specify a binary number.

In *linguistics* almost every sentence we speak or write can be viewed as a loose logical product of its words. For a sentence means whatever its words simultaneously and jointly mean. It is the product class, X^0_S whose factor classes are its words or semantic phrases (i.e., $X^0_S = X^0_{ABC \ldots N} = X . X^0_B . X^0_C \ldots\ldots\ldots\ldots X^0_N$). Thus 99 per cent or more of our language and thinking may be built up of entities symbolizable by a zero exponent — however vague or loose or unconscious this use of X^0_A usually is. This statement implies that the more definite, tight, and conscious our use of X^0 becomes, the more excellent our language may become. "More excellent" is used in the semantic sense of a more exact one-to-one correspondence between symbol and symbolized — so that each word has just one meaning. This should tend to reduce the schizoid condition in our world today where the lack of correspondence between what is said and what happens produces so much frustration in human affairs. In the physical sciences this gap is almost nil so that manipulating the symbols as in chemical equations agrees closely with the behavior of phenomena symbolized. But in the social sciences with larger gaps often between symbol and symbolized, between speech and action, manipulating words about human behavior agrees very imperfectly with that later behavior. With less of a gap — such as may result in part from using the zero exponent well — the social scientist should be able to predict human action increasingly better.

Another future use of zero in linguistics is developed by a new language which we have christened "Tilp." This is an analytic language in that it analyzes the larger part of all language into ten elementary symbols — including zero. This gives an alphabet of ten elements of meaning which can spell out over half of all that language says. By experimental tests on samples of a dozen Asiatic and European languages, their connective half (as distinguished from the substantive half of each language) has been reduced to words built wholly as logical products from these ten dimensional elements. This "inter-language" can be used with substantive words of any language to form a half-internationalized language of great precision and simplicity. Its precision can be that of symbolic logic — to which the exponent zero contributes a share. Its simplicity is such that novices have learned it from scratch and translated 200-word paragraphs all within two hours. To describe this ten-letter language would be an excursion too far afield from the field of the zero exponent to which this paper is limited.[6] But this wider field of futurable languages may be glimpsed in passing since the zero exponent, along with other improved

[5]For fuller implications of binary elements see Dodd, S. C., "All-or-none Elements in Mathematical Models for Sociologists," *American Sociological Review*, April 1952.

[6]For fuller description of Tilp see: Dodd, S. C., *Systematic Social Science*, University Book Store, Seattle, 1947, pp. 679-85; Dodd, S. C., "Tilp — a ten letter alphabet of meanings," *General Semantics Bulletin*, Nos. 6 and 7, 1951.

symbols, may be a means for jet-propelling human language and consequent thinking up from its present ox-cart stage of development.

IV. *The Zero Exponent in the Empirical Sciences*

Turning from the sketch above of samples of the zero exponent's possible uses in semantic fields, consider next some samples of its use in the empirical sciences. The use of the X^0 symbol for specifying assumptions or conditions, definitions or relations, classifications or qualifications may be illustrated briefly, without discussion, each in one science. Examples of these six uses will be chosen from the sciences of physics and chemistry, biology and psychology, sociology and all science, respectively.

In physics the formula for gravity, like every scientific law, *assumes* certain pre-conditions (including the meaning of the words in which the law is stated). Thus the formula for the force (F) of gravity, as illustrated in the accompanying design, is the product of the mass (M) of a body times the gravitational constant (g) (= an acceleration of about 32 feet per second though varying slightly with latitude), i.e., $F = gM$. But this assumes two prerequisite conditions which may be symbolized by C_1^0 and C_2^0. The first condition (C_1^0) is that the force is measured at the earth's surface. If measured elsewhere, g has a different value. The second condition (C_2^0) is that the force is to be measured in a vacuum if perfect accuracy is wanted. For if air or other more viscous medium intervenes between the object and the earth, the object will fall with a different acceleration. Thus both the acceleration and the force are reduced to zero if the intervening medium is so solid that the object cannot fall. These implicit conditions can be explicitly stated in the formula. The student is then warned of the limiting assumptions of the law of gravity here by using zero exponents in the equation, thus:

$$F = g\,M\,C_1^0\,C_2^0$$

This says that the force of gravity is equal to the gravitational constant times the mass if at the earth's surface and in a vacuum.

In chemistry every reaction takes place as stated in its equation only under certain *conditions.* These conditions can be explicitly written in the equation telling the chemist what operations he must perform to make the reaction take place or go forward fully in one direction. Thus, for example, the breaking down of copper chloride, $CuCl_2$, into its ingredients may be written simply as: $CuCl_2 = 2\,Cu + Cl_2$

This says that one molecule of copper chloride yields one atom of copper and a molecule of chlorine. But it says nothing of the conditions necessary to break down the copper chloride. If this decomposition is done by passing an electric current (= E^0) through a solution (F_2^0) of copper chloride, then one gets copper in metallic form (F^0) and chlorine in gaseous form (F_3^0). All this can be explicitly stated in the reaction equation below, which combines the usual quantitative data as to amounts of the reagents with qualitative data as to the conditions before, during, or after the reaction:

$$CuCl_2\,E^0F_2^0 \Rrightarrow CuF_1^0 + Cl^2\,F_3^0$$

Note that since every quantity with-a-zero-exponent equals 1, the qualifying conditions are unities and do not alter the quantities of the reagents but only *qualify* them.

In biology, as in every science, the principles developed are dependent upon the *definitions* of the terms in the principle as stated. One attempt to define terms more rigorously, for example, has been made by Woodger.[7] He uses symbolic logic to supplement the empirically observed relations in developing a system in biology. The logic is based on carefully defined classes. Let each class be symbolized by a letter-with-zero-exponent. Let the rules of symbolic logic (or Boolean algebra) be made to harmonize further with the rules of ordinary algebra.[8] Then this biological system, aided a bit by the zero exponent, becomes expressible in algebraic formulas.

In psychology, the analytic schools search for psychological elements — whether sensations, reflex arcs, dream symbols, acts, or other unit parts. The synthetic schools emphasize wholes — whether called a pattern, total response, personality, goal-behavior, or other synthesizing concept. Much of the difference often is in the degree of emphasis on the *relations* of the parts to the whole. The most complete picture includes the parts, their relations and all combinations of all these up to the whole, of course. The semantics of relations, whether applied to people in psychology or by people in any science, is developing nowadays in such fields as the calculus of relations in symbolic logic, the theory of groups, sets, lattices, and matrices, topology, etc., in mathematics, and the grammars of artificial languages in linguistics. In this development the zero exponent may play a part since any relation can be symbolized by an X-to-the-zero-power with suitable subscript. Then the algebra of relations can become harmonized more with ordinary algebra. Thus a syndrome of psychiatric symptoms that diagnoses a psychoneurotic patient can always be written in an algebraic formula with the aid of zero exponents, if it can be expressed in words at all.

[7]Woodger, J. S., *Axiomatic Method in Biology,* Cambridge University Press, 1937, 174 pp.

[8]One further step in harmonizing is to define the logical sum so as to exclude the logical product in order to get this generalizing of qualitative algebras.

In the field of social psychology, the logistic hypothesis of growth of human interaction of the person-to-person type can be rigorously deduced when aided in this semantic *operation* by the zero exponent. To deduce the logistic principle here, arrange a set of persons as heads of rows and of columns as in the matrix below. Let the inter-

	${}^{A}P^{0}$	${}^{B}P^{0}$	${}^{C}P^{0}$		${}^{N}P^{0}$	
${}^{A}P^{0}$	—	${}^{AB}P^{0} \cdot {}^{1}A^{0} = 1$	${}^{AC}P^{0} \cdot {}^{0}A^{0} = 0$	pq	${}^{AN}P^{0} \cdot {}^{0}I^{0} = 0$	p
${}^{B}P^{0}$	${}^{BA}P^{0} \cdot {}^{0}A^{0} = 0$ p^2	—	${}^{BC}P^{0} \cdot {}^{1}A^{0} = 1$		${}^{BN}P^{0} \cdot {}^{1}A^{0} = 1$	
${}^{C}P^{0}$	${}^{CA}P^{0} \cdot {}^{0}A^{0} = 0$	${}^{CB}P^{0} \cdot {}^{0}A^{0} = 0$	—		${}^{CN}P^{0} \cdot {}^{0}A^{0} = 0$	q
	pq			q^2		
${}^{N}P^{0}$	${}^{NA}P^{0} \cdot {}^{0}A^{0} = 0$	${}^{NB}P^{0} \cdot {}^{0}A^{0} = 0$	${}^{NC}P^{0} \cdot {}^{0}A^{0} = 0$		—	
	p		q			p + q = 1

action be some attribute ($= {}^{1,0}X^{0}$) such as "told" or "not told" a rumor. Each cell entry is the product of three factors, namely: (1) the name of the row person, such as ${}^{A}P^{0}$; (2) the name of the column person, such as ${}^{B}P^{0}$; and (3) the attribute "told" ($= {}^{1}A^{0} = 1$) or "not told" ($= {}^{0}A^{0} = 0$). Each of the cells, N^2 in number, is a pair unit, ${}^{AB}P^{0}$ ($= 1$) or two-person group which is multiplied by the attribute, ${}^{1,0}A^{0}$. Each cell records a 1 if the column person were told by the row person, a 0 if he were not told by that row person. Let p be the proportion (collected together in the first section of the matrix) who know the rumor and let q be the rest (so $p + q = 1$). Assume a homogeneous population, i.e., one with equal opportunity for anyone to meet anyone else. Let the population interact with each other which means mathematically that $p + q$ is multiplied by itself, i.e., the knowers of the rumor and the non-knowers mix around well. This product of $p + q$ people times $p + q$ people is $p^2 + 2\,pq + q^2$. Here p^2 (the upper left section of the matrix) represents knowers talking with knowers with no spreading of the rumor. q^2 (lower right section) represents non-knowers talking with each other — again with no spreading of the rumor. pq represents knowers talking with non-knowers and here is where the rumor may spread. So pq represents the probable increment in the proportion of knowers in a unit period. This is written in the differential equation:

$$dp/dt = a\,p\,q$$

which says that each bit of change (dp) in the knowing proportion in a bit of time (dt) equals the product of a constant a and the knowing (p) and non-knowing (q) proportions. Adding up these increments gives the integrated form of this equation as the logistic S-shaped growth curve (see accompanying diagram). This is:

$$p_t = \frac{1}{1 + q_0/\,p_0\,e^{-at}}$$

where p is the proportion of knowers at successive dates, t

p_0, q_0 is the initial proportion of knowers and its complement

$e = 2.718$, the base of natural logarithms

$a =$ a parameter, called the "potency of the rumor" here, or average growth rate. It fixes the steepness of the curve. ($a/4 =$ the tangent at the mid point, where growth is greatest)

This logistic hypothesis of growth of all-or-none interacting, or diffusion of an attribute, should hold in any "homogeneous" population. It will fit data closely in proportion as that homogeneity condition holds, i.e., to the extent that each has equal opportunity to interact, however heterogeneous the population may be in other respects. It has been called the growth curve of a contagious disease without immunity, or the curve of imitative behavior. It is a case of a social hypothesis, mathematically deduced from the assumption of equally-interacting people, which is being empirically supported in so far as that condition holds in a social situation.

In sociology, the zero exponent has assisted in a systematic *classification* for all human phenomena as diagrammed in the "quantic solid." This simultaneously classifies any recorded human situation or set of data into four classes called sectors, namely: time (T), space (L), people (P), and the complement class of indicators of everything else (I). These are cross-classified without overlap or residue by their common "quantics," or exponents, from zero to three. The resulting 256 cells in the quantic solid ($4 \times 4 \times 4 \times 4 = 256$) have been found adequate by controlled experiments to classify all data about people as far as these 256 dimensions can describe people and their environs. Any set of data related to people can be classified in some cell of this quantic solid — most often in cells with zero exponents. Several hundred of the standard concepts of sociology, for example, have been re-expressed in terms of these dimensions. A complete textbook of systematics for the social sciences has been written using only these four sectors and their four powers. As usual in this paper, these summarizing statements on the use of the zero exponent must be abbreviated here with the interested reader referred to fuller evidence and explanation elsewhere.

In *cosmology*, the zero exponent has helped to develop a striking regularity. This is a distribution, shaped like an isosceles triangle, of all material entities from quanta of energy through atoms and cells, to human groups at the apex, and on through planets and stars to the entire universe. Its graph appeared on the cover page of MAIN CURRENTS, Vol. 7, No. 4, and its description there was entitled "An Isosceles Distribution of Material Entities."

All material entities were classified along two coordinates, each specified by two alternate *qualifications* (as factors in a logical product). One coordinate, the base of the isosceles triangle, measures the mass (or alternatively the diameters) of each material entity. The other coordinate, the altitude of the triangular distribution, measures each entity's evolutionary age in five class-intervals (or alternatively the rank of the relevant science as social (0^{th}), human (1^{st}), biological (2^{nd}), physical (3^{rd}), and astronomical (4^{th}). The units of both coordinates are integral logarithms or exponents. The origin on both scales is the apex of the triangle as fixed by zero exponents — a mass to the zero power and time to the zero power. The zero exponents are located at the present moment in time and at the mass of the average human group (estimated to lie between 2 and 10 persons). With these defining qualifications including the zero exponent symbol, the regular triangular distribution of material entities emerges as a candidate law of cosmology.

This triangle predicted the mass of the universe as 10^{74} protons before this estimate of Professor Harlow Shapley's was known to the author.

The sides of the triangle are specified by the equation

$$m = \pm 11R$$

where m is exponent of mass and R is the rank of the relevant science. This may be written in alternative terms of distance (diameters) and time (age), in the simple equation below where the square brackets denote a dimensional formula:

$$[L = T]$$

This states the equivalence here of the dimensions of distance and time.

If this isosceles distribution should become accepted as a cosmic law, the zero exponent will share in the credit for its discovery.

STATEMENT OF OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946.

Of MAIN CURRENTS in Modern Thought published Quarterly at Port Chester for October 1st, 1951. State of New York, County of Westchester. Before me, a Notary Public in and for the State and county aforesaid, personally appeared F. L. Kunz, who, having been duly sworn according to law, deposes and says that he is the editor, publisher and owner of the quarterly MAIN CURRENTS in Modern Thought and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily, weekly, semiweekly or triweekly newspaper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the act of August 24, 1912, as amended by the acts of March 3, 1933, and July 2, 1946 (section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, F. L. Kunz, Port Chester, New York; Editor, F. L. Kunz, Port Chester, New York; Managing Editor, None; Business Manager, None. 2. That the owner is (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) F. L. Kunz, Port Chester, New York. 3. That the known bondholders, mortgages, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. (Signed) F. L. Kunz.

Sworn to and subscribed before me this 5th day of October, 1951, Arden W. Smith, Notary Public in the State of New York, appointed for Westchester County (Commission expires March 30, 1953).

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